SUB-BASIN EVALUATION

Strategic Environmental Assessment of the Hydropower Sector in Myanmar

IN PARTNERSHIP WITH:

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MOEE

MONREC

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ABBREVIATIONS

CIA	Cumulative impact assessment
Cn	loss of nutrients and organic matter
Cs	Salinization
ESIA	Environmental and social impact assessment
EST	Estimated
FFI	Fauna & Flora International
GIS	Geographic information system
GoM	Government of Myanmar
HDWG	Hydropower Developers' Working Group
HPP	Hydropower project
IFC	International Finance Corporation
IWMI	Integrated Water Management Institute
KBA	Key biodiversity areas
KIO	Kachin Independence Army, Kachin Independence Organization
km	kilometer
KNU	Karen National Union
MIID	Myanmar Institute for Integrated Development
MIMU	Myanmar Information Management Unit
MOEE	Ministry of Electricity and Energy
MONREC	Ministry of Natural Resources and Environmental Conservation
MW	Megawatt
NR	Natural resources
PA	Protected area
PRC	People's Republic of China
SAZ	Self-administered Zone
SB	Sub-basin
SDF	Sustainable Development Framework
SEA	Strategic Environmental Assessment
SEP	Stakeholder Engagement Plan
SN	Soil renewal
WCS	Wildlife Conservation Society
Wd	Terrain deformation/mass movement
WWF	World Wildlife Fund for Nature

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1 INTRODUCTION

An evaluation of baseline environmental and social conditions in Myanmar's eight drainage basins including the Ayeyarwady, Thanlwin, Mekong, Myit Mo Hka and Bago, Sittaung, Bilin, Tanintharyi, and Rakhine was undertaken to provide an overview of the types, extent and value (importance) of natural and social resources potentially affected by medium and large scale (≥10 MW capacity) hydropower development. The country-wide evaluation provides information on features that enable whole-of-basin hydropower planning and GIS layers that provide an overview of basin conditions.

To analyze variable conditions and different features across entire basins[1], six of the eight basins were divided into discrete sub-basins. The two smallest basins, Bago and Bilin, were analysed as single drainage areas. Sub-basins were selected as the primary spatial unit for analysis within each basin in the SEA because:

- they are discrete natural drainage units directly affected by medium/large scale hydropower development, with impacts on river flows, water quality, geomorphology, aquatic habitat, and biodiversity occurring within this area;
- this level of detail aligns with the main intended use of the Sustainable Development Framework (SDF) for early project screening prior to successively more detailed planning in cumulative impact assessments (CIAs) and project environmental and social impact assessments (ESIAs); and
- more detailed analysis at the watershed level within a sub-basin was not possible given current information limitations.

A total of 58 sub-basins were delineated throughout Myanmar (Figure 1.1). This mosaic of natural drainage areas enables analysis and management planning at the two most important system levels: basin and sub-basin. Analysis down to the watershed level was not possible given current information limitations (i.e. some layers of data provide finer level information but not all layers are this detailed). As more detailed information is obtained, natural and social resources analysis will be added, completing a multi-scale approach to hydropower planning.[2]

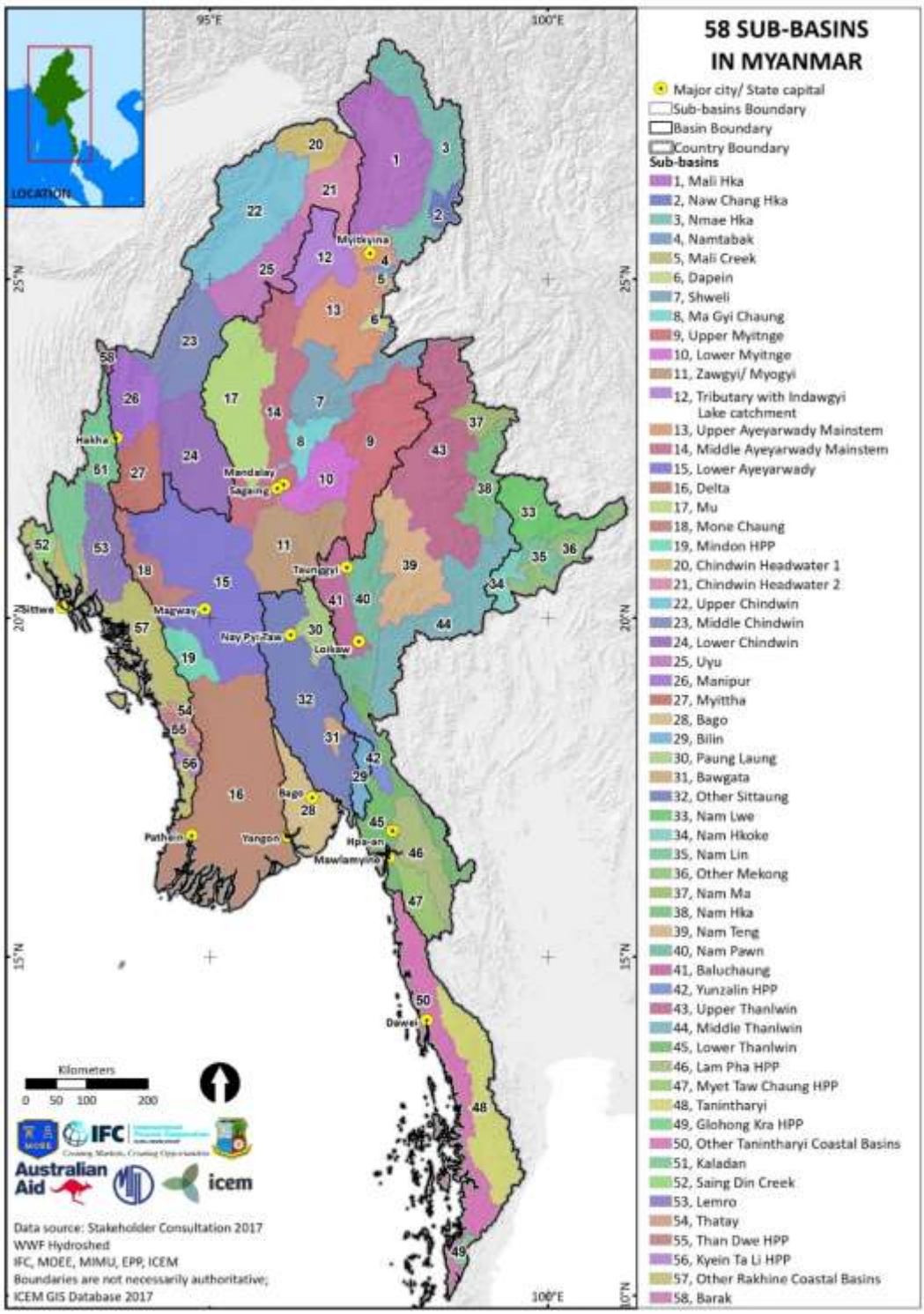
Sub-basins were identified using HydroSHED[3] levels. Most sub-basins (43) were selecting using HydroSHED level 6 boundaries. Some Level 6 HydroSHEDs were divided into Level 7, 8 or 9 drainage areas, especially where large hydropower projects or cascades exist or are planned. Some Level 7, 8 and 9 drainage areas were combined to create sub-basin areas of a suitable size for strategic analysis.

Fifty-two sub-basins drain directly into the basin mainstem river / major tributary or sea, with the remaining six sub-basins each draining into a downstream sub-basin before discharging into the mainstem / major tributary. Six sub-basins that discharge into another sub-basin were delineated as being separate from the downstream sub-basin due to their large size or distinct features (e.g. significant existing HPPs). These sub-basins are: Naw Chaung Hka discharging into the Nmae Hka; Upper Myitnge discharging into the Lower Myitnge; Myittha discharging into the Manipur; Balachaung discharging into the Nam Pawn; and Paung Luang and Bawagata both discharging into

[1] Definitions of important terms:
River basin - an area of land from which all surface runoff flows through a sequence of streams, rivers and, possibly, lakes into the sea at a single river mouth, estuary, or delta.
Coastal basin – a collection of sub-basins along the coastal belt, many of which drain directly into the sea in numerous places rather than via a single discharge point.
Sub-basin – a discrete drainage area within large river basin.
Watershed - a discrete drainage area within a sub-basin.
[2] G. Pegram, Y. Li, T. Le. Quesne, R. Speed, J. Li, and F. Shen. 2013. River Basin Planning: Principles, procedures and approaches for strategic basin planning. Paris, UNESCO.

the Sittuang Other. Accordingly, the connectivity of these six sub-basins with the free-flowing mainstem or the sea is dependent upon what occurs within the downstream sub-basin.

Figure 1.1: Myanmar sub-basin



1.1 Evaluation Criteria

Baseline information and spatial data were compiled to evaluate the existing conditions and trends. Only key biophysical and socio-economic 'values' were analysed, relating to those features likely to be significantly impacted by hydropower development, as well as the status of armed conflict.

Information and data sources included published information, spatial data and expert opinion. Existing GIS layers were utilized where available and reliable (e.g. forest cover).

An overview description of each sub-basin was developed covering major biophysical features, socio-economic features, local administration, and the status of hydropower development. Environmental and social scores were assigned to each of five strategic themes for each sub-basin:

1. Geomorphology and sediment
2. Aquatic ecology and fisheries
3. Terrestrial biodiversity
4. Social and livelihoods
5. Conflict

For each theme a set of evaluation criteria or indicators were identified to best provide an indication of the relative value of that theme. Indicators were generally selected where reliable and uniform data was available country-wide. Each indicator was scored on a relative scale then used to calculate the overall theme rating for each sub-basin. The five themes in each sub-basin received a rating of between 1 to 5, with 1 indicating a Low value and 5 a Very High value. The methodology applied for baseline evaluation is described detail in Section 2.

Table 1.1: Indicators used to evaluate each theme

Theme	Indicator
Geomorphology	• River connectivity and delta and coastline stability • Potential sediment production • Flow input
Aquatic ecology and fisheries	**Ecologically value rating:** • River reach rarity • Presence of endemic species • Key Biodiversity Areas (KBAs), Ramsar sites, and important wetlands • Confluences • Karst geology • Presence of threatened fish and aquatic organisms **Human pressure rating**: • Deforestation • Agriculture and mining intensity • Urban and rural population • Road infrastructure • Hydropower and irrigation dams[4]
Terrestrial biodiversity	• Key Biodiversity Areas % • Intact forest % • Presence of endangered ecoregions
Social and livelihoods	• Social vulnerability = % of female-headed households (Census 2014) • Dependence on natural resources (NR) = the mean % of "Own Account Workers as % of work force" in townships within sub-basins (Census 2014) • Poverty = % of households that own a television (Census 2014)
Peace and conflict	• Presence and status of ethnic armed groups • Historical population displacement • Conflict incidents 2012-2017

[4] The impact of existing hydropower and irrigation reservoirs was considered for sub-basins with existing HPPs.

1.2 Sub-basin Evaluation Summary Sheets

An evaluation sheet was prepared for each sub-basin summarizing the main environmental and social conditions relating to hydropower development and the status of armed conflict in each sub-basin.

Table 1.2: Sub-basin evaluation sheet format and data sources sub-basin evaluation

Sub-basin: **Basin:**			
Overview	**Size, location, topography and map**		
Physical	**Area (km^2)**: GIS measurement **Average rainfall:** **Average sub-basin outflow:** **Minimum outflow:**		
Socio-economic	**Population***:* Estimated using Census 2014 data and village tract population **Ethnic diversity***: Myanmar Information Management Unit 2015 – data on ethnolinguistic groups* **Economic activities***:* *Mining: Mining disturbance data (Eco-Dev/ALARM, 2016)* *Land use: Land Use (LU)/Land Cover (LC) (IWMI, 2015)* *Navigable waterways: Official waterways for freight and passenger transport as defined by the Ministry of Transport and Communication (ADB, 2016)*		
Administration	**States/Regions**: *GIS analysis* **Major town(s):** *As above*		
Hydropower development	*Numbers of existing, planned, under-construction hydropower projects sourced from HPP database prepared in consultation with MOEE*		
Sub-basin evaluation			
Aquatic ecology and fisheries		**Rating**	**1-5**
Geomorphology and sediment		**Rating**	**1-5**
Terrestrial biodiversity		**Rating**	**1-5**
Social, livelihoods, and significant sites		**Rating**	**1-5**
Conflict		**Rating**	**1-5**

A summary of the sub-basin evaluation results, including national maps and summary tables for each theme, is presented in Section 3.

1.3 Information Limitations

Sub-basin baseline data was limited in many key areas, including river hydrology and geomorphology, riverine ecosystems and aquatic species, and socio-economic conditions. In the

absence of detailed information, indicative or proxy information was used to assess some features, or the information was not evaluated. Specific information limitations for each discipline are described in Section 2.

The sustainable development framework will be periodically revised as key information becomes available. In the short to medium term more detailed information and data will be obtained through a combination of studies that are underway or planned. This includes studies and data collection identified in the SEA as being essential to implement effective hydropower planning, the monitoring of operational hydropower projects by GoM and private developers, and feasibility studies and impact assessments undertaken by hydropower developers.

Key studies that will help to inform the first revision of the SDF include the Ayeyarwady Integrated River Basin Management Project (AIRBM) being undertaken by the National Water Resources Committee with support from The World Bank, and a number of research projects supported by the Water, Land and Ecosystems (WLE) Initiative of the Consultative Group for International Agricultural Research (CGIAR).

2 METHODOLOGY

2.1 Geomorphology and Sediment Transport

This analysis aims to describe the large-scale characteristics of sub-basins contributing to the geomorphic functioning of river systems at the sub-basin and basin levels. River geomorphology is largely controlled by water and sediment inputs as well as how they are transported downstream to the delta and the sea. This approach assumes that if the sediment and water inputs and pathways in a river have not been altered, then its geomorphology will remain intact. This analysis does not focus on small-scale, reach-level geomorphic attributes, which are incorporated into the aquatic ecology analysis using “rare and unique river reaches” as an input parameter.

This analysis also does not consider local land-use changes that can affect sediment and water inputs despite their importance. There are two reasons for this: firstly, these impacts can change from years to decades, but the impact of hydropower on the geomorphology of river systems needs to be considered on time scales of decades to centuries. Local land-use changes, such as mining increasing sediment input, water extraction for irrigation reducing flood peaks, or river improvements for navigation altering channel geometry, are likely to experience significant changes over centuries and are difficult to project into the future.

Secondly, most of Myanmar has been affected by soil loss due to land degradation (Figure 2.1), but there is insufficient information about the relative magnitude of impacts on the sub-basins to incorporate this into the analysis. The adopted methodology assumes that steeper and wetter areas, whether degraded or not, will contribute more sediment as compared to lower-sloped and drier areas.

For each sub-basin, three large-scale parameters are assessed: 1) connectivity, 2) sediment production potential, and 3) flow input. The parameters, the input information used for evaluating the parameters, and the rationale for inclusion in the analysis are summarized in Table 2.1.

Figure 2.1: Soil degradation for Myanmar showing widespread loss of topsoil

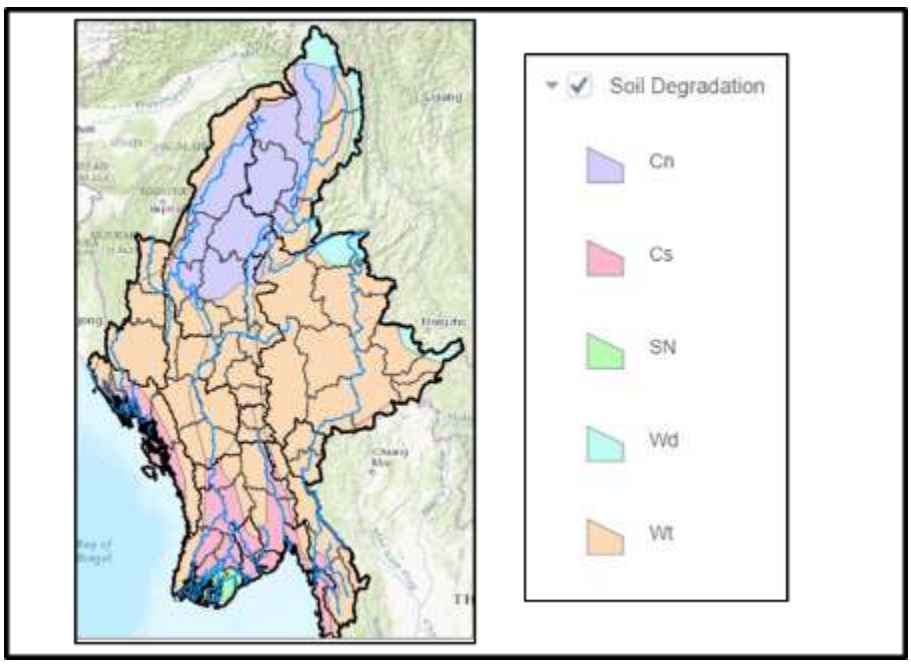
Other degradation classes are:

Cn = Loss of nutrients and organic matter

Cs = Salinization

SN = Soil renewal

Wd = Terrain deformation/mass movement



A score of 1 to 5 was assigned to the three indicators for each sub-basin and together, they make up the final sub-basin rating. For each indicator, 5 denotes the highest 20% of the basins with respect to sensitivity to change or value, indicating that a sub-basin is functioning at or close to its natural state, while 1 is assigned to the lowest 20% of the sub-basins. A low value indicates that a sub-basin is already being modified with respect to the parameter. Details of how scores were derived for each indicator are presented in the following sections.

Table 2.1: Summary of geomorphology and sediment transport parameters, input information, and rationale for inclusion in the analysis

Indicators	Input parameters	Rationale
1. River connectivity/ delta and coastline stability	• Strahler order[5] • Area of sub-basin • Position of sub-basin with respect to the coast • Size and distribution of existing dams	River systems are maintained by the production and transport of sediment from the headwaters of rivers to the sea. Delta and coastline stability are dependent on the delivery of material from river systems. Dams reduce the connectivity of rivers, prevent the passage of sediment, or alter the flow regime of rivers, thereby fundamentally altering geomorphic processes.
2. Potential sediment production	• Distribution of the geomorphic land units identified within sub-basins	Potential sediment production is a measure of how much sediment a sub-basin is likely to generate. It is dependent on geology and slope, and altered by land-use changes. Areas generating coarse grained sand and gravel provide the materials that maintain channel, delta, and coastline stability. Areas generating fine-grained material provide transport for nutrients to flood plains and underpin coastal productivity.
3. Flow input	• Rainfall/runoff • Sub-basin area • Position of sub-basin with respect to the coast	The unregulated flow of water through river systems transports sediment, shapes river channels and establishes the seasonal timing of processes that control ecological functioning (e.g. flood pulse, dry season, floods, etc.).

2.1.1 Connectivity

Connectivity scores were calculated based on the highest Strahler Order present in the sub-basin, the sub-basin area, and the presence of existing hydropower projects. For the analysis, the sub-basin areas were ranked by percentile to provide their relative difference while eliminating the order of magnitude difference among them. The percentile value was multiplied by the Strahler Order and then assigned a value of 1-5 based on percentile rankings (e.g. 1st-20th percentile = 1, 21st-39th percentile = 2, etc.).

This initial scoring was modified based on the presence of existing or under-construction hydropower projects within the sub-basins. Sub-basins with existing projects are shown in Table 2.2 and the connectivity scores were modified based on the following criteria:

- No modification if <5% of the sub-basin is located upstream of hydropower projects
- Score reduced by 1 if >5% but <90% of the sub-basin is located upstream of hydropower projects
- Score reduced by 1 if the connectivity of the sub-basin is reduced due to hydropower projects in a downstream sub-basin (only applied to the Upper Myitnge sub-basin)
- Score reduced by 2 if >90% of the sub-basin is located upstream of hydropower projects.

[5] Strahler Order is a measure of the complexity of river systems based on the number of tributaries feeding into a river reach. Small headwater streams have a Strahler Order of 1, and the joining of two Strahler Order 1 tributaries creates a Strahler Order 2 river reach, as shown in the diagram (Strahler, 1952, 1957). The joining of a higher order (e.g. 3) with a lower order (e.g. 2) does not increase the Strahler Order downstream.

Totals that resulted in negative values, or zero, were scored as 1.

Table 2.2: Characteristics of sub-basins with existing or under-construction hydropower projects and connectivity adjustment factor

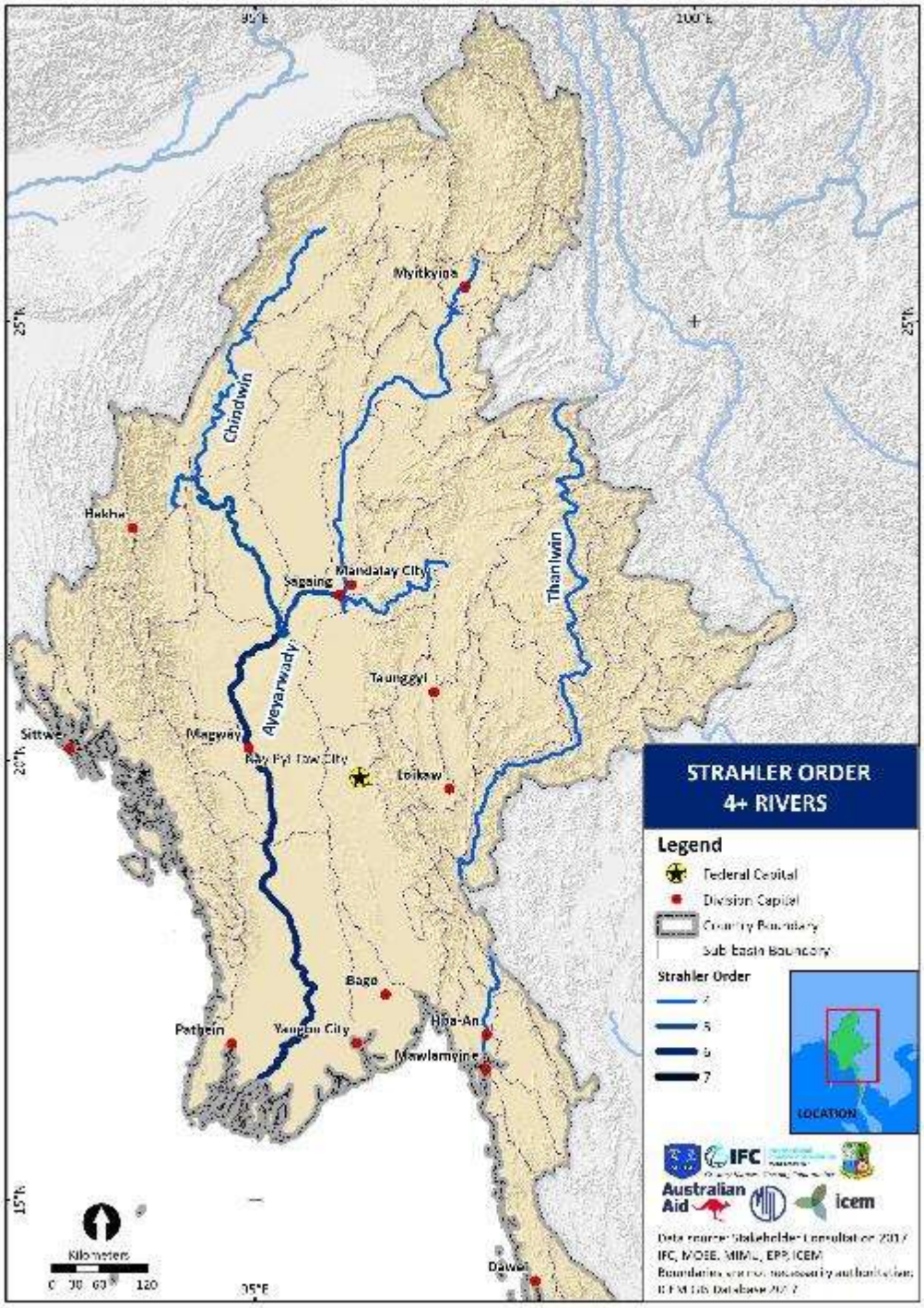
SB #	Sub-basin (SB)	Number of HPPs in SB	Max. Strahler Order	Approx. % of catchment upstream HPPs	Connectivity adjustment factor
3	Lower Myitnge	2	4	>90	-2
4	Ma Gyi Chaung	1	2	80	-1
5	Mali Creek	1	1	40	-1
6	Dapein	1	3	>90	-2
9	Mone Chaung	3	2	80	-1
10	Mu	1	3	50	-1
12	Nmae Hka	1	3	<5	0
13	Shweli	2	3	>90	-2
16	Upper Myitnge	0	3	0	-1*
17	Zawgyi/Myogyi	4	4	60	-1
21	Bago	1	2	10	-1
46	Myittha	1	3	20	-1
52	Nam Lwe	1	3	>90	-2
64	Thatay	1	1	>90	-2
72	Other Sittaung	6	3	30	-1
73	Paung Laung	3	2	90	-2
91	Balachaung	4	2	>90	-2
96	Nam Teng	2	3	40	0

** The Upper Myitnge sub-basin does not have any hydropower projects, but connectivity is affected by the projects in the Lower Myitnge sub-basin.*

In the connectivity assessment, the mainstem of the Ayeyarwady, Chindwin, and Thanlwin with Strahler Order 4 or greater were excluded from the analysis and treated as unique units. These mainstem reaches (Figure 2.2) play a critical role in providing pathways for sediment, water, fish, and other aquatic organisms to move through the system and were assigned a ranking of 5 in the vulnerability analysis. Sub-basins containing the mainstem reaches were assigned the highest Strahler Order present in the sub-basin excluding the mainstem and evaluated as described above.

In the Lower Myitnge and Manipur sub-basins, there are rivers with a Strahler Order of 4 but are not mainstems of the Ayeyarwady, Chindwin, or Thanlwin. They were not considered as a special case and were included in the connectivity indicator scoring along with all other sub-basins.

Figure 2.2: Strahler Order 4+ rivers considered as a special case for "connectivity"



2.1.2 Potential Sediment Input

The potential sediment input score was calculated based on the distribution of geomorphic land units – determined from the physical attributes of the landscape – in each sub-basin. Figure 2.3 shows the distribution of these geomorphic classes in each sub-basin with examples.

Each land class was assigned a weighting based on its estimated relative sediment production potential as summarized in Table 2.3. Steeply sloping areas on hard rock were given the highest value due to their potential to produce sand and gravel, which are critical for river-channel stability and habitat maintenance.

Each sub-basin's score was calculated by multiplying the weighting by the percentage of each of its geomorphic land class present. The percentile ranking of these scores was used to assign final scores of 1 to 5, similar to the method applied to the other indicators. The potential sediment input scores for the Shweli, Dapein, and Upper Thanlwin were adjusted by +1 to account for the large catchment areas and high sediment input potential associated with the catchments located outside of Myanmar.

Figure 2.3: Geomorphic land classes based on geology and slope

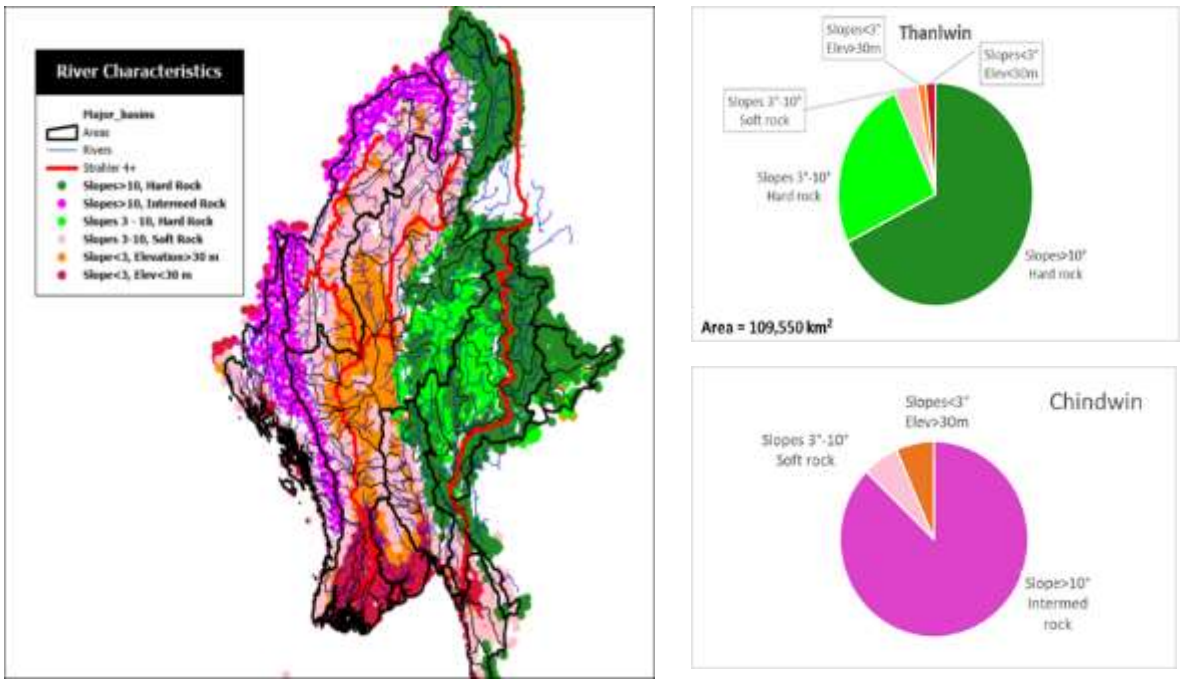


Table 2.3: Weightings for determining sediment production potential

Geomorphic class	Sediment production potential weighting
Slopes >10° and hard rock geology	5 - High potential to produce sand and gravel
Slopes >10° and intermediate hardness geology	4 - Good potential to produce sand and gravel, silt, and clay
Slope <10° and hard geology	3 - Moderate potential to produce sand and gravel
Slope 3-10° and soft geology	2 - Low potential for sand and gravel; high potential for silt and clay
Slopes <3° and elevation >30 m	1 - Very low input of "new" sediment; areas of re-working
Slope <3° and elevation <30 m	0 - Generally areas of deposition and re-working

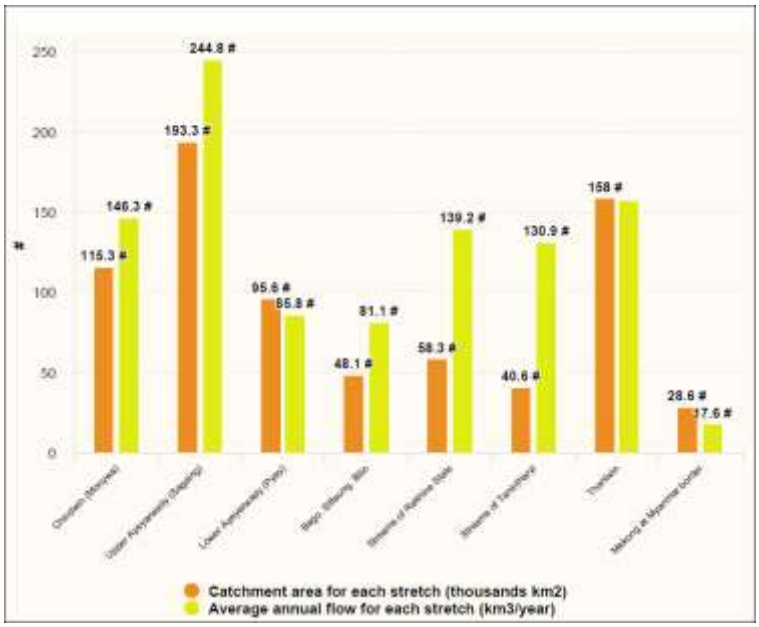
2.1.3 Flow Input

The flow input indicator was calculated based on the water volume input from each sub-basin using the following calculation:

Area of SB X average rainfall in SB X runoff coefficient = water volume Input

The runoff coefficient was estimated using the information in Figure 2.4 with the results for each catchment shown in the table below.

Figure 2.4: Catchment areas and average annual flow rates of the major river basins in Myanmar used to derive catchment runoff



Basin	Runoff coeff.
Upper Aye	0.83
Lower Aye	0.54
Chindwin	0.73
Bago	0.80
Sittaung	0.80
Rakhine	0.77
Thanlwin	0.72
Tanintharyi	0.98
Mekong	0.57

The resultant water volumes were ranked by percentile similarly to the other indicators (e.g. 1st-20th percentiles = "1", 21st-39th percentiles = "2", etc.).

For sub-basins containing a mainstem reach, only the inflow from the sub-basin area was considered. The importance of the through-flow of water in the mainstem reach was recognized and accounted for in the connectivity score.

2.1.4 Final Sub-basin Ratings

The final sub-basin ratings for geomorphology were determined by adding the three indicator scores and normalizing the total to a range of 1 to 5. Scores that were <0.5 were assigned a final score of 1.

2.2 Aquatic Ecology and Fisheries

Sub-basin evaluation of aquatic ecology and fisheries involved: i) identifying the ecological values of river sub-basins and ii) analyzing existing human pressures on each river reach.

The ecological value of river sub-basins in Myanmar was calculated based on combining multiple GIS layers to determine the ecological sensitivity of river reaches within each sub-basin. The analysis process is described below, completed with the calculations for estimating the ecological value. A supplementary process for describing human pressures on each river reach and sub-basin is also described.

2.2.1 Ecologically Sensitive River Reaches

The analysis was based on World Wildlife Fund for Nature's (WWF's) River Reach Classification for the Greater Mekong Region (2014). The basic spatial unit of this classification is "river reach," a linear unit representing a stretch of river between two consecutive confluences. Lehner and Allaire's classification applied a range of hydrological, physio-climatological, and geomorphological classifications to the river reaches. In addition, this analysis applied a set of geospatial variables linked to the ecological sensitivity of the river reaches of the Ayeyarwady and Thanlwin basins to create an overall measure, classifying river reaches as having low, medium, high, or very high ecological sensitivity.

Another set of geospatial variables related to negative human pressures was applied to the river reaches of the Ayeyarwady and Thanlwin to develop a combined score. Those river reaches with scores below a defined threshold were classified as having low, medium, high, or very high human pressure.

2.2.2 Ecological Sensitivity

2.2.2.1 River Reach Rarity

Lehner and Dallaire's (2014) combined classes refer to an aggregate of hydrological, physio-climatological, and geomorphological classifications. The total length of the river reaches within each of Lehner and Dallaire's (2014) Combined classes was calculated for the basins. The Combined class is an aggregate of a range of hydrological, physio-climatological and geomorphological classifications. The total length of the river reaches within each of the different river sizes (Mainstem, Large, and Medium, Small rivers and headwater streams) was also calculated for the basins. The percentage of the total length of each river size occupied by each of the Combined classes was then calculated. This percentage was used to score each reach for rarity, so that reaches occupying 0-5% of their river size were given a rarity score of 4, reaches occupying 5-10% were given a score of 3, reaches occupying 10-20% were given a score of 2 and the remainder, occupying 20-71%, were the most common Combined classes, and were given a score of 1. Mainstem reaches were given an automatic score of 5 to reflect their importance. The rarest river reaches - with combined class reaches in 0-5% of their constituent Simple Hydrological class - were given a rarity score of 4; those in 5-10% received a score of 3; those in 10-20% received a score of 2; the remainder 20-71% - the most common - were given a score of 1.

Table 2.4: Combined classes and total length of river reaches in Myanmar (*Source: Lehner & Dallaire, 2014*)

Combined class description	Sum reach length (km)	Percentage simple hydrological	Rarity score
Large river, in dry broadleaf forest region, with floodplains	0.63	0.01	4
Medium river, in dry broadleaf forest region, with low gradient	18.74	0.09	4
Large river, in mangrove region	8.50	0.12	4
Large river, in montane region, with low gradient	12.16	0.17	4
Medium river, in montane region, with high gradient	145.32	0.73	4

Combined class description	Sum reach length (km)	Percentage simple hydrological	Rarity score
Large river, in moist broadleaf forest region at high elevation, with low gradient	56.07	0.78	4
Medium river, in mangrove region	185.76	0.93	4
Medium river, in moist broadleaf forest region at low elevation, with high gradient	245.39	1.23	4
Large river, in dry broadleaf forest region, with floodplains and sediment	108.99	1.52	4
Medium river, in moist broadleaf forest region at high elevation, with high gradient	325.86	1.64	4
Medium river, in karst within montane region	347.02	1.74	4
Medium river, in moist broadleaf forest region at high elevation, with floodplains	363.43	1.83	4
Medium river, in coniferous region, with high gradient	422.47	2.12	4
Large river, in moist broadleaf forest region at high elevation, with floodplains	169.94	2.37	4
Main stem, meandering channel with alluvium	112.68	2.39	4
Medium river, in dry broadleaf forest region, with floodplains	493.92	2.48	4
Large river, in moist broadleaf forest region at low elevation, with floodplains and sediment	204.91	2.86	4
Large river, in karst region at high elevation	206.21	2.88	4
Large river, in karst within montane region	251.70	3.51	4
Large river, in moist broadleaf forest region at high elevation, with sediment	353.20	4.93	4
Medium river, in coniferous region, with low gradient	1,172.14	5.89	3
Medium river, in montane region, with low gradient	1,239.07	6.23	3
Large river, in large delta region	448.08	6.25	3
Medium river, in large delta region	1,284.07	6.45	3
Main stem, large delta	304.58	6.47	3
Medium river, in moist broadleaf forest region at high elevation, with low gradient	1,305.72	6.56	3
Large river, in moist broadleaf forest region at low elevation, with low gradient	506.75	7.07	3
Medium river, in karst region at high elevation	1,436.37	7.22	3
Large river, in moist broadleaf forest region at low elevation, with sediment	634.06	8.85	3
Large river, in coniferous region, with low gradient	1,033.71	14.42	2
Medium river, in karst region at low elevation	2,980.58	14.98	2
Medium river, in moist broadleaf forest region at low elevation, with floodplains	3,215.01	16.16	2
Main stem, anastomose channel	959.36	20.38	1
Large river, in moist broadleaf forest region at low elevation, with floodplains	1,585.62	22.12	1
Large river, in karst region at low elevation	1,587.79	22.15	1
Medium river, in moist broadleaf forest region at low elevation, with low gradient	4,719.35	23.72	1

Combined class description	Sum reach length (km)	Percentage simple hydrological	Rarity score
Main stem, rock-cut river channel	3,330.83	70.76	1

2.2.2.2 Endemic Areas

Polygons delineating the presence of endemic species were determined based on literature, e.g. (Allen, 2010), and consultation with organizations such as FFI and Wildlife Conservation Society (WCS). River reaches intersecting these areas were given a score of 3.

2.2.2.3 Key Biodiversity Areas, Ramsar sites, and important wetland areas

Polygons delineating KBAs were obtained from the World Database of Key Biodiversity Areas. Additional KBAs were identified during a workshop held in June 2017 as an important activity of the SEA. Expert reviews further classified these areas as terrestrial only, terrestrial or river, aquatic birds, or fully riverine wetland. Areas recognized as globally important, e.g. Ramsar sites, World Heritage sites, or part of the 2004 Wetland Inventory, were given the highest scores. River reaches intersecting these areas were scored as follows:

Table 2.5: Scores for KBA classification

KBA classification	Score
Recognized as globally important	**5**
Fully riverine wetland	4
Aquatic birds	3
Terrestrial on river	2
Terrestrial only	1

2.2.2.4 Confluences

Confluences are recognized areas mixing water and migration routes, often with important habitat features. They can be both ecologically and culturally significant. River confluence points were identified by reviewing the reach classification dataset. Buffer zones of varying sizes were applied to each point to create an expert defined area of influence. River reaches intersecting these areas of influence were given the following scores in Table 2.6.

Table 2.6: Scores for confluence type and buffer size (km)

Confluence type	Buffer size	Score
Large river confluence with large river	10 km	2
Large river confluence with main stem	20 km	3

2.2.2.5 Karst Geology

River reaches classified as flowing through Karst landscape by Lehner and Dallaire 2014 were given a score of 3.

2.2.2.6 Presence of Threatened Fish and Other Aquatic Organisms

The predicted presence of critically endangered, endangered, and vulnerable species of fish and other aquatic organisms in each sub-basin was taken from the IBAT/Redlist Freshwater Assessment. River reaches within those sub-basins were scored as follows:

Table 2.7: Scores for presence of threatened fish and other aquatic organisms

Reach intersects with a basin polygon where the presence of Red List fish species (sp.) has been indicated	Vulnerable fish	Endangered fish	Critically endangered fish
Score	3	4	5

Reach intersects with a basin polygon where the presence of Red List fish species (sp.) has been indicated	Vulnerable fish	Endangered fish	Critically endangered fish
Reach intersects with a basin polygon where the presence of Red List species (not fish) has been indicated	Vulnerable aquatic sp. (not fish)	Endangered aquatic sp. (not fish)	Critically endangered aquatic sp. (not fish)
Score	3	4	5

2.2.2.7 Combined Ecological Sensitivity Scoring

A combined ecological sensitivity score was then calculated for each river reach, with a range of +1 to +23:

- Reaches with a score of less than or equal to 4 were classified as low sensitivity.
- Reaches with a score between +4 and +9 were classified as medium sensitivity.
- Reaches with a score between +9 and +13 were classified as high sensitivity.
- Reaches with a score greater than +13 were classified as very high sensitivity.

2.2.2.8 Developing an Ecological Value for the Sub-basins

The ecological sensitivity scores of all river reaches within a sub-basin were then combined to derive a total ecological value for each sub-basin. The combination was done by weighting the length of each river reach with its ecological sensitivity score and dividing by the total length of river reaches in that sub-basin. These values were then normalized on a scale of 1-5, where 1 indicates a basin with very low ecological value and 5 with the highest ecological value.

For sub-basins containing a mainstem reach, only the inflow from the sub-basin area was considered. The ecological value of the mainstem portions was excised from the calculations of sub-basins through which the mainstems of Ayeyarwady, Chindwin and Thanlwin are flowing. The ecological value thus reflects only the tributaries flowing into the mainstems in these sub-basins.

2.2.3 Human Pressures

Human pressures are an indicator of the state of river health. The higher the pressures from different human activities, the more likely the river quality and character will suffer.

2.2.3.1 Deforestation

Lehner and Dallaire's (2014) river-reach classification included a measure, derived from the Global Land Cover 2000 project, of the percentage of the upstream watershed covered with forest. A low percentage was considered a valid proxy for deforestation. The following scores were applied to river reaches depending on the value of upstream forest cover (Table 2.8).

Table 2.8: Scores for values of upstream forest cover

Deforestation	Upstream forest cover	Score
Low	40-60%	-1
Medium	20-40%	-2
High	0-20%	-3

2.2.3.2 Agriculture and Mining

Experts assessed the impact of agriculture and mining by applying scores to each HydroBASINS level 6 sub-basin. HydroBASINS is a global database with a series of polygon layers that depict watershed boundaries and sub-basin delineations. The database provides consistently sized and hierarchically nested sub-basins, following the topological concept of the Pfafstetter coding system. This allows for analysis of issues such as upstream and downstream connectivity. River reaches intersecting the sub-

basins were given a score of between -1 and -5 for both the impact of mining and agriculture based on the expert assessment.

Agricultural intensity was calculated from the area of agricultural land within each sub-basin, factored by the area of double and triple cropping. Land-use data has been taken from an Integrated Water Management Institute (IWMI) database. The index calculation took the percentage of cultivated area in the sub-basin and multiplied this by the percentage of agricultural land that was double- or triple-cropped. This was then multiplied by 1,000, yielding index ranges from 0 to over 3,000. Each river reach in the sub-basin was then given a score as shown in Table 2.9.

Table 2.9: Agricultural intensity index

Agricultural intensity index ranges	Score
0 – 25	1
25-250	2
250-750	3
750 – 3,000	4
>3,000	5

Mining intensity was calculated from the mining area dataset from Myanmar Information Management Unit (MIMU). This dataset was overlaid on the hydro basins level 6; then the mining intensity index was calculated by dividing the area of mines in hectares divided by the area of each hydro basin in square kilometres multiplied by 1,000, yielding a range of indices between 0 and 25,000. The river reaches in each sub-basin were then scored as shown in Table 2.10.

Table 2.10: Mining intensity index

Mining intensity Index ranges	Score
0 – 25	1
25 – 250	2
250 – 2500	3
2,500 - 10,000	4
>10,000	5

2.2.3.3 Urban Population Centers

The locations and populations of major urban areas in Myanmar were obtained from MIMU. Areas of influence were then delineated downstream of the population centers; the size of an area was dependent on the size of the population center and the size of the river affected by the population center. River reaches intersecting the area of influence from a population center were given a negative score depending on the size of the population centre. See below table for details of the sizes of areas of influence and scoring (Table 2.11).

Table 2.11: Scores for urban population centers, river size, and length of downstream influence

Urban population centers	River size	Length of downstream influence	Score
> 1 million people	Mainstem river	50 km	-5
> 1 million people	Large river	75 km	-5
> 1 million people	Medium river	100 km	-5
100,000 - 1 million people	Mainstem river	25 km	-4
100,000 - 1 million people	Large river	50 km	-4
100,000 - 1 million people	Medium river	100 km	-4

Urban population centers	River size	Length of downstream influence	Score
100,000 - 1 million people	Small river	125 km	-4
10,000 - 100,000 people	Mainstem river	10 km	-3
10,000 - 100,000 people	Large river	25 km	-3
10,000 - 100,000 people	Medium river	50 km	-3
10,000 - 100,000 people	Small river	100 km	-3

2.2.3.4 Rural Population Density

The rural population density was used as a measure of pressure from rural populations on the aquatic natural resources. The data came from WWF's River Reach Classification for the Greater Mekong Region (Lehner and Dallaire 2014), which incorporated a field of population density above each river reach (Table 2.12).

Table 2.12: Rural population density

Rural population density	Number of people per sq km above each river reach				
Reach has a rural population score of	<= 25	> 25 and <= 50	> 50 and <= 100	> 100 and <= 500	> 500
River reach score	0	-1	-2	-3	-4

2.2.3.5 Road Infrastructure Density

The road infrastructure overlay was obtained from MIMU. This was correlated with the sub-basins and the density of road infrastructure calculated by the area of each sub-basin. The estimated road density indices for all river reaches in each sub-basin are shown in Table 2.13.

Table 2.13: Road density

Road density	Length of road per area of sub-basin (km/sq km)				
Reach intersects with a basin polygon with a road index	0.0-0.025	0.025-0.05	0.05-0.075	0.075-0.1	0.1-0.224
River reach score	0	-1	-2	-3	-4

2.2.3.6 Dams Downstream

The HPP database generated by the SEA was used to determine the location of hydropower and irrigation dams as well as the areas of influence for each dam. These areas stretched downstream from each dam up to the next confluence with a river reach with a higher hydrological class. River reaches intersecting a dam area of influence were given the scores shown below in Table 2.14.

Table 2.14: Dam types and influence

Dam type	Score
Irrigation	-3
Hydro >100 MW	-4
Hydro <100 MW	-3
Hydro <50 MW	-2

2.2.3.7 Reservoirs

The extent of dam reservoirs was ascertained from the Global Surface Water database. River reaches intersecting a dam reservoir (irrigation or hydropower) were given a score of -5.

2.2.3.8 Combined Human Pressure Index

A combined pressure score was then calculated for each river reach with scores ranging from -1 to

-24.

- Reaches with a score between -1 and -5 were classified as very low pressure.
- Reaches with a score between -5 and -10 were classified as low pressure.
- Reaches with a score between -10 and -15 were classified as medium pressure.
- Reaches with a score between -15 and -20 were classified as high pressure.
- Reaches with a score between -20 and -24 were classified as very high pressure.

2.2.3.9 Developing a Human Pressure Index for the Sub-basins

The human pressure scores on all river reaches within a sub-basin were combined to derive a human pressure index for each sub-basin. The combination was done by weighting the length of each river reach with its human pressure score and dividing it by the total length of river reaches in that sub-basin. These values were then normalized on a scale of 1-5, where 1 indicates a basin with very low human pressure and 5 with the highest pressure. This analysis was used to describe the trends in each sub-basin's aquatic environment.

2.3 Terrestrial Biodiversity

In considering terrestrial biodiversity, the SEA identifies areas of biodiversity value countrywide and then grades all regions according to criteria that reflect biodiversity importance. This process provides a national comparative analysis that represents the attributes of Myanmar's biodiversity without being too computationally demanding.

Myanmar is a recognized biodiversity hotspot, supporting a very high number of species unique to the region and of global importance. Yet, information on Myanmar's biodiversity is patchy with large areas of the country unsurveyed. For example, in 2014, 26 species of plants and animals were newly described for Myanmar. Since then, there has been a steady stream of discoveries as the level of effort and investment increased; big gaps, however, remain. Therefore, a national biodiversity assessment needs to use forms of aggregated information, proxies, and expert judgment to achieve a comprehensive and reliable picture.

2.3.1 Assessment Parameters

The assessment used four main parameters or criteria for identifying areas of biodiversity value: key biodiversity areas (KBA), protected areas (PA), intact forests, and ecoregions. Each parameter reflects a complex mix of biodiversity ingredients such as species, ecosystems, and genetic resources; each is a combination of field-based information, spatial interpretation, and expert judgment and experience. Together, they provide a rich and reasonably accurate strategic picture of the nature, extent, and location of remaining biodiversity in the country.

The analysis was conducted at two geographic levels for the 14 river basins nationwide and the 58 sub-basins.

2.3.2 Key Biodiversity Areas

The KBA designation is a new tool for identifying areas of remaining important biodiversity. Using globally standardized criteria and thresholds, KBAs are identified across the country and represent the most important sites for biodiversity conservation worldwide. They provide a vital habitat for threatened plant and animal species in terrestrial, freshwater, and marine ecosystems.

Sites qualify as global KBAs if they meet one or more of 11 criteria clustered into five categories: threatened biodiversity, geographically restricted biodiversity, ecological integrity, biological processes, and irreplaceability. They are an "umbrella" designation, usually covering existing protected areas, Important Bird Areas, Important Plant Areas, and Important Sites for Freshwater Biodiversity.

The identification of KBAs is an evolving tool to help countries fill critical gaps in their national system of protected areas and to support development planning and environmental assessment so that negative impacts on biodiversity can be avoided.

In Myanmar, KBAs have no legal standing as an official form of land tenure except where they overlap with formally established protected areas. They cover many different forms of land tenure, ownership, and use, making their effective management to maintain and enhance biodiversity an all-of-government responsibility.

A preliminary KBA listing for Myanmar was considered at a January 2012 stakeholder workshop convened by the Wildlife Conservation Society, resulting in the identification of 132 KBAs. To update this initial KBA database, the SEA convened a second two-day working session of government agencies, international conservation organizations, local nongovernmental organizations, the private sector, and academia in July 2017. The KBA boundaries were defined based on field research, GIS analysis, expert knowledge, and participatory mapping. As a result, KBAs now cover close to 41% of the country including 182 sites; boundaries will continue to be adjusted and refined based on further biodiversity surveys and collective expert knowledge and experience. This assessment of biodiversity values uses the updated KBA database.

2.3.3 Protected Areas

In Myanmar, the national protected area (PA) system covers almost 6% of the country, including national parks, wildlife reserves and sanctuaries, forest parks, and nature reserves. PA boundaries are officially defined under national legislation. PAs are the mainstay of biodiversity conservation and associated products and services in the country.

While some KBAs and PAs overlap, the KBA network is more extensive and representative of remaining biodiversity values in Myanmar. The establishment of PAs in Myanmar reflects historical links with forest administration, hunting, and recreational uses; it is not a systematic process based on relative biodiversity importance and values. But the SEA decided to include PAs in this biodiversity assessment because their establishment over the past 10 years has been shaped by conservation priorities such as the tiger reserve in the Northern Ayeyarwady basin.

2.3.4 Intact Forests

The assumption underlying the use of intact forests as a proxy for biodiversity is that they provide greater species biodiversity, productivity of goods, variety and integrity of services, and connectivity attributes and processes than degraded forests. Intact forests are an unbroken expanse of natural ecosystems showing no sign of significant human activity and large enough to maintain all native biodiversity, including viable populations of wide-ranging species. The lower their exposure to humans, the greater the ability of ecosystems to support their natural biological diversity and ecological processes as well as absorb and recover from disturbance (resistance and resilience).

Two important sources of data were used in analyzing forests of Myanmar: the Myanmar Forest Cover Change (2002-2014) study and Hansen et al. (2013). Data from the Myanmar Forest Cover Change study were used to create cover maps of intact forests (greater than 80% canopy cover), degraded forests (between 10% and 80% canopy cover), and plantation and non-forests (less than 10% canopy cover), as well as graphs and tables of intact forests, degraded forests, degraded regions, and changed forest cover.

Plots of annual cumulative loss of forests by basin, where forest loss was determined for open and medium-closed canopy cover, and intact forests, were derived from Hansen et al. (2013). The canopy cover metrics adopted for these plots were based on those from the Myanmar Global Forest Resources Assessment 2015, and the Myanmar Forest Cover Change (2002-2014) study. The term “open forest” refers to forest with greater than 10% and less than or equal to 40% canopy cover; “medium-closed forest” has a canopy cover of more than 40%; and “intact forest” has greater than 80% canopy cover. The term “medium-closed” rather than “closed” (as defined in the Myanmar Forest Resources Assessment) is used as the latter better describes the three categories of canopy cover presented in this study: open, medium-closed, and intact forest. More details on the methodology adopted for forest analysis is given in Chapter 3.

2.3.5 Ecoregions

Myanmar is represented by 14 ecoregions, which describe the original assemblage of plants, animals, climate, and geomorphological characteristics in the country. Each ecoregion is a large area of land containing a geographically distinct mix of species, natural communities, and environmental conditions. Ecoregions are areas where ecosystems (and the type, quality, and quantity of environmental resources) are similar.

They are identified by analyzing the patterns and composition of biotic and abiotic phenomena that affect or reflect differences in ecosystem quality and integrity. These phenomena include geology, landforms, soils, vegetation, climate, land use, wildlife, and hydrology. The relative importance of each characteristic varies from one ecological region to another. In this assessment, the key attribute that needs to be kept in mind is that ecoregions represent what was there, not necessarily what remains. When combined with one or more of the other parameters, ecoregions are an important source of information on the relative value of biodiversity found in KBAs, PAs, and intact forests.

2.3.6 Biodiversity Sub-basin Evaluation

The four parameters were used in two ways to define areas of biodiversity value in Myanmar. As overarching proxies for biodiversity, KBAs and intact forests were combined to make up a biodiversity index that identified areas of value within each river basin and ranked river sub-basins from very low to very high value. PAs and ecoregions were then applied to ensure certain important areas were not overlooked in the index because they were relatively small or their values were not properly recognized and described.

First, KBAs and intact forests were overlaid on river basins and the total percentage coverage of each parameter calculated. That index provided a measure of current biodiversity status. Also, annual cumulative forest losses from 2002 to 2014 for each basin were graphed for i) open forests, ii) medium-closed forests, and iii) intact forests. The analysis of cumulative forest loss allowed for the definition of trends in biodiversity.

Second, biodiversity index ratings were calculated for the 58 sub-basins as follows (Table 2.15):

- % KBAs (1 to 5 score)
- % intact forests (1 to 5 score)
- Add scores and average
- Results in a rating from very low to very high value (i.e. five sub-basin categories)

The 1 to 5 scores were given based on equally distributed percentiles, with each score representing 20% of the total range. The percentile ranges were defined by the highest value among each sub-basin, which was 99% for KBAs and 85% for intact forests.

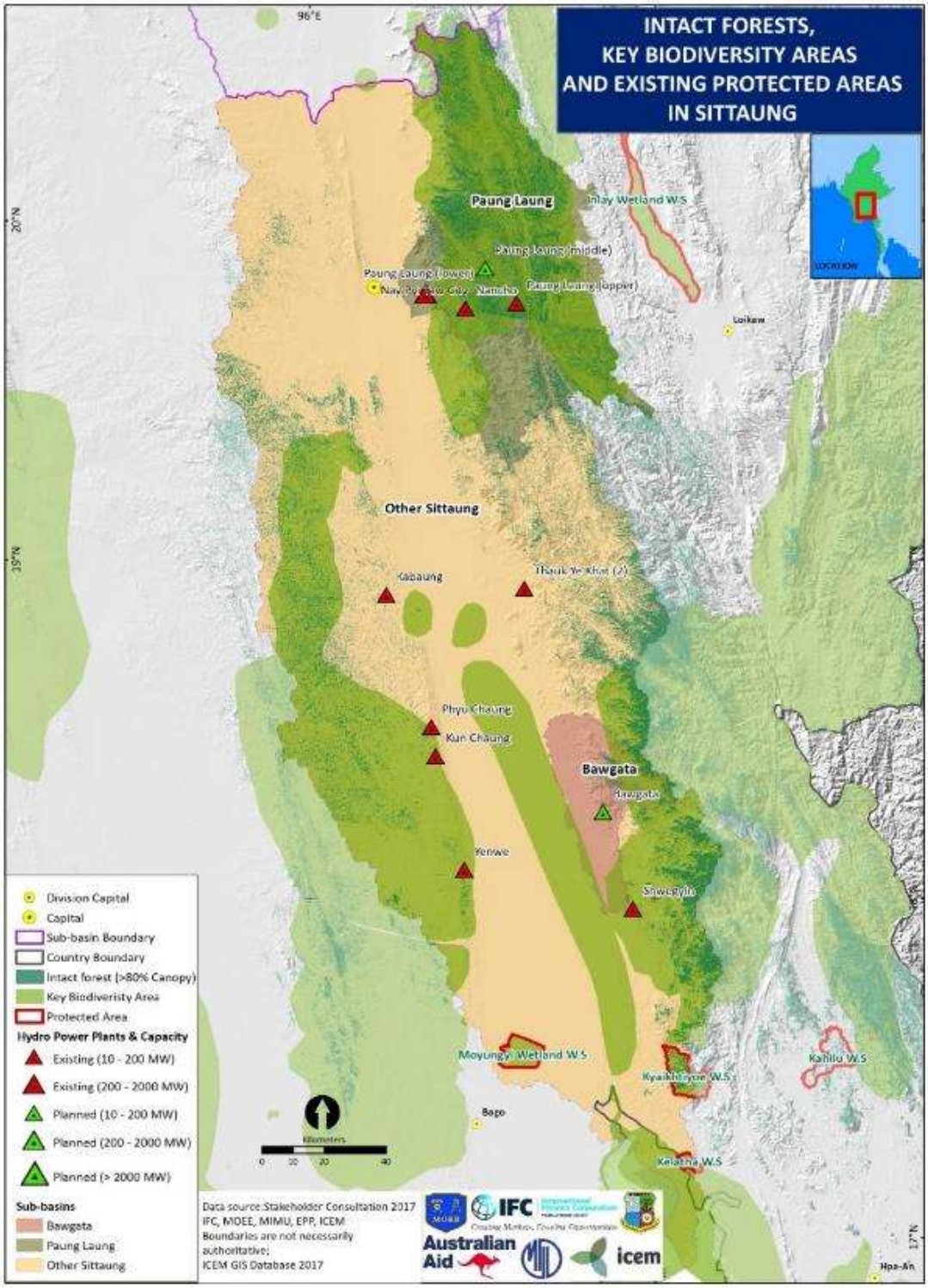
The method is illustrated in Figure 2.5 and Table 2.15 for the three Sittaung sub-basins.

Table 2.15: Biodiversity value ratings for the Sittaung sub-basins

Main basin		**Sittaung**		
Sub-basin		*Paung Laung*	*Bawagata*	*Other Sittaung*
Total area (km$^{2)}$		4,986.0	1,229.2	28,698.3
Number of HPPs		4	1	6
PA	**Area (km^2)**	0.0	0.0	212.2
	%	0.0	0.0	0.7
Intact forests	**Area (km^2)**	1,045.2	86.2	2,418.4
	%	21.0	7.0	8.4
	Score	2	1	1
KBA	**Area (km^2)**	3,668.4	412.7	9,905.1
	%	73.6	33.6	34.5
	Score	4	2	2
Sub-basin score		**3**	**2**	**2**

Third, critically endangered ecoregions and PAs were mapped to identify sub-basins or small pockets of biodiversity of global importance that were not captured in the KBA and intact forest index. For example, the Irrawaddy Dry Forest ecoregion is critically endangered, but due to its small stature, relatively low forest canopy cover (around 60%), and remaining small vestiges, it was not picked up by the index. Identifying the location of the dry forest and small PA or KBA pockets coinciding with the ecoregion gave the sub-basin a gold star of exceptional value, even though it might not be ranked highly using just the biodiversity index. A gold star means that the sub-basin warrants special care and safeguards when any development is considered.

Figure 2.5: Key biodiversity areas and intact forests in the Sittaung sub-basins



2.4 Social and Livelihoods

2.4.1 Summary of Criteria in Calculating Overall Theme Score

The criteria for the selection of indicators were as follows:

- Indicator's relevance for hydropower development

- Availability of nationwide quality-checked data
- Transparency – for stakeholders to be able to provide inputs
- Simplicity – for replicability and integration into the overall score

Three indicators were selected for the following three aspects of social vulnerability:

1. ***Social vulnerability = % of female-headed households (Census 2014)***

   Female-headed households are assumed to be more vulnerable to social change as they often have only one head of family and fewer income earners than male-headed households, which often have at least two.

2. ***Dependence on natural resources = mean % of "own account workers as % of workforce" in townships within sub-basins (Census 2014)***

   This category includes independent, self-employed people (farmers, fishers, handicraftsmen, etc.) who are assumed to be more vulnerable to potential hydropower impacts such as relocation and changes in land and water access.

3. ***Poverty = % of households owning a television (Census 2014)***

   This indicator for general poverty level was selected several regression analysis runs on the only available rural poverty data from 2010. The data were by State/Region/Division and were placed as the independent variable, while Census 2014 data on township percentages of households having various house materials (bamboo, wood, concrete, etc.), drinking water source, ownership to various assets (car, truck, motorbike, mobile phone, etc.) were placed as dependent variables. None of the tested Census 2014 variables had a significant statistical correlation with the poverty data from 2010 (at PValue < 0.005). The percentage of households owning a TV was the only indicator that had a significant correlation with the 2010 poverty data and was therefore selected as the poverty indicator.

The index was constructed as follows:

Allocation of townships to sub-basins were based on township area centroids (their mid-point), thereby transforming polygons to points so that township and sub-basin boundaries would not overlap. The steps for constructing the vulnerability rating were:

1. Census 2014 percentages of households with various characteristics by township were averaged by sub-basin.
2. The 10th percentile of the average percentages were calculated and given a score from 1 to 10, 1 being the lowest score in terms of social vulnerability.
3. The scores from the three indicators were added and the 20th percentile for these values were calculated. Each percentile was given a score between 1 and 5. This is the total social vulnerability rating presented here.

2.5 Peace and Conflict

This methodology for sub-basin and sustainability analysis links hydropower development to the presence and likelihood of conflict by sub-basin and hydropower project, respectively. Armed conflict is a constraint to hydropower development; in instances where the precursors of armed conflict are present, hydropower development can potentially exacerbate conflict. Critically, this methodology does not consider how hydropower is developed. The "legacy model" of hydropower development, as described in the conflict baseline of the hydropower SEA, has been a driver of conflict. The final SEA report will consider approaches where hydropower development can mitigate conflict risks and potentially address some of Myanmar's underlying conflict drivers.

Key issues

1. Political disputes over governance and territory
2. Issues related to equality and human rights
3. Patterns of violence associated with contested territory

Each trend had at least one indicator for the vulnerability analysis. Data for each indicator were normalized from their raw form and scaled 1-5. Indicators were combined to produce evaluation vulnerability ratings scaling from very low (light green) to very high (dark green).

For the sustainability analysis, each of the three indicators were applied to specific projects, using a 1-3 scale. Only proposed (not existing) projects were assessed. Indicators were combined, giving each project an impact score ranging from 3 (low) to 9 (high).

2.5.1 Sub-basin Evaluation

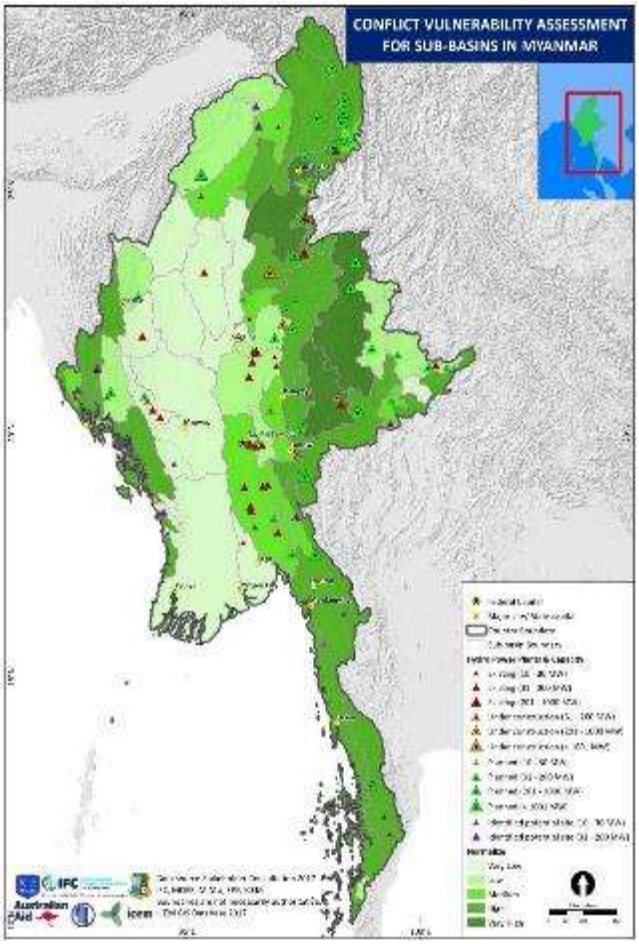
Indicator Criteria	Methodology	Results
1. Presence and status of armed groups (disagreement over governance and territory)	The presence of armed groups in sub-basins was scaled from 1-5: 1: No armed group presence or no armed group with constitutional territory (accommodated claims); 3: Tolerated claims (ceasefires); 5: Hostile claims to territory (conflict). These measures were averaged when the composition of armed group presence within sub-basins was mixed. Data were sourced from the Asia Foundation.	The presence and status of armed groups are intrinsically linked to historical and contemporary disputes over governance and territory. They pose differing conflict risks depending on the nature (or absence) of political agreements between the armed groups and the state.
2. Historical population displacement (proxy indicator for equality and rights issues) *0.5 weighting*	A five-point scale for historical population was based on the following categories: 1: 0-29 2: 30-499 3: 500-1,999 4: 2,000-10,000 5: 10,000 + Data and scaling were sourced and adapted from the United Nations Office for the Coordination of Humanitarian Affairs.	Historical population displacement is a proxy measure for a variety of equality and rights issues that can complicate hydropower development and act as a conflict driver (e.g. land tenure issues, relatively limited access to services/weaker social contract, relatively high human rights abuses, etc.). Populations displaced by conflict are significantly more likely to have experienced human rights abuses.

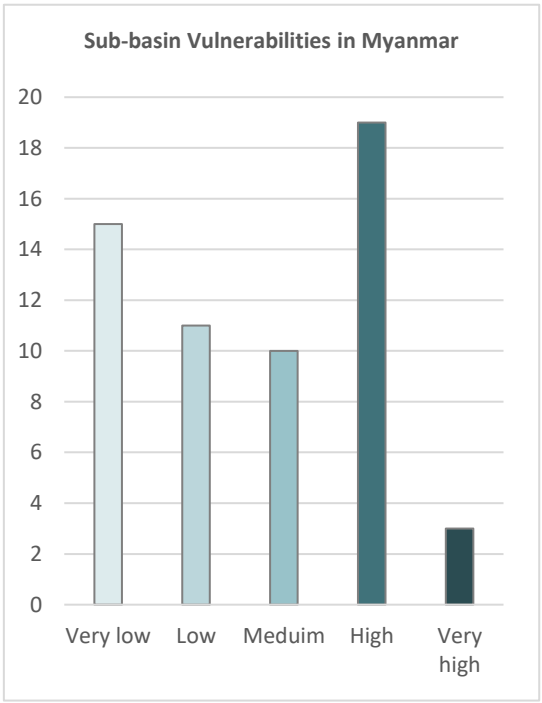
Indicator Criteria	Methodology	Results
3a. Conflict incidents 2012-2016 (patterns of violence associated with contested territory)	A logarithmic scale was used based on the average number of conflict incidents per year for each sub-basin. The accuracy of this scale has been compared against the Heidelberg Institute for International Conflict Research (HIIK) 2012-2016 global conflict barometer results. 1: 0 conflict incident 2: 1 conflict incident 3: 2-3 conflict incidents 4: 4-9 conflict incidents 5: 10+ conflict incidents Data were sourced from the Myanmar Peace Monitor (www.mmpeacemonitor.org)	Armed conflict in sub-basins poses a challenge to hydropower development and is associated with potential delays or scrapping of such projects. Armed conflict is a significant risk – a potential show stopover – and may need to be considered differently compared to vulnerability ratings of other themes. Hydropower development also poses a risk to initiate or exacerbate conflict in areas where territories are contested, same as under the first indicator.
3b. Estimated battle deaths 1989-2015 (patterns of violence associated with contested territory) *0.5 weighting*	The estimated numbers were normalized to the HIIK conflict intensity rating (country/year) on a scale of 1-5: 1: 25> 2: 25-49 3: 50-199 4: 200-499 5: 500+ Data were sourced from the Uppsala Conflict Data Program, which estimated battlefield deaths based on media, academic, and civil society reporting.	Both historical and contemporary conflict data were included to make conclusions more robust. More importantly, the decision to include historical conflict data is because even in peaceful areas, the potential for violence remains as Myanmar has yet to reach sustainable political agreements to end its armed insurgencies. Historical instances have shown repeatedly that the country's peaceful areas under ceasefires can turn violent abruptly, which will have significant implications for hydropower development in those areas. Also, hydropower development, if mismanaged, can be damaging for the political process that aims to move beyond ceasefires to reach permanent political agreements.

2.5.2 National Map of Conflict Sub-basin Evaluation

Fewer than half of the sub-basins (45%) received "very low" or "low" conflict vulnerability ratings. Ten sub-basins (17%) were rated "medium," 19 (33%) were "high," and three (5%) were "very high." The very high ratings in Myanmar's west were a result of the high incidence of intercommunal conflicts and displacement in Rakhine State between 2012 and 2016. Most sub-basins in or across Ayerwaddy, Yangon, Bago, Magwe, Mandalay, and Saigang regions were rated "low" or "very low," given the relative absence of armed group activity, population displacement, or armed violence in these areas.

Most sub-basins in Kachin and northern Shan states had “high” or “very high” conflict vulnerability ratings due to the presence of multiple armed groups and frequent conflict and population displacement between 2012 and 2016. Sub-basins in southern and eastern Shan states, as well as Kayin and Kayah states, and the Tanintharyi region, were rated as “medium” or “high” because of the presence of multiple armed groups, high historical conflict, and high historical displacement, even though many of these areas are currently under ceasefires. The Thanlwin (especially), Rakhine, and parts of the Ayeyarwady basin (middle) returned the highest conflict vulnerability ratings.





3 NATIONAL MAPS AND SUMMARY TABLES

3.1 Summary

The baseline ratings (1-5) for each of the five themes were overlaid on national maps to show the biophysical, socio-economic, and conflict values in the 58 sub-basins.

The geomorphology, aquatic ecology and fisheries, and terrestrial biodiversity baseline values were grouped as biophysical ratings. Thirty-three sub-basins have high (4) or very high (5) ratings.

Social and livelihoods and conflict were treated as separate themes for analysis. For social and livelihoods, four sub-basins are rated very high and 15 sub-basins have high ratings. Conflict was categorized as “yes” (*rating 4-5*) or “no” (*rating 1-3*). Six sub-basins have very high conflict ratings and 15 have high ratings.

Table 3.1 provides a summary of the sub-basin ratings for each theme. The ratings will serve as a guide to areas that require focused protection in terms of management and investment and identify areas that can be further developed under strict conditions.

Figure 3.1: Geomorphology baseline value ratings

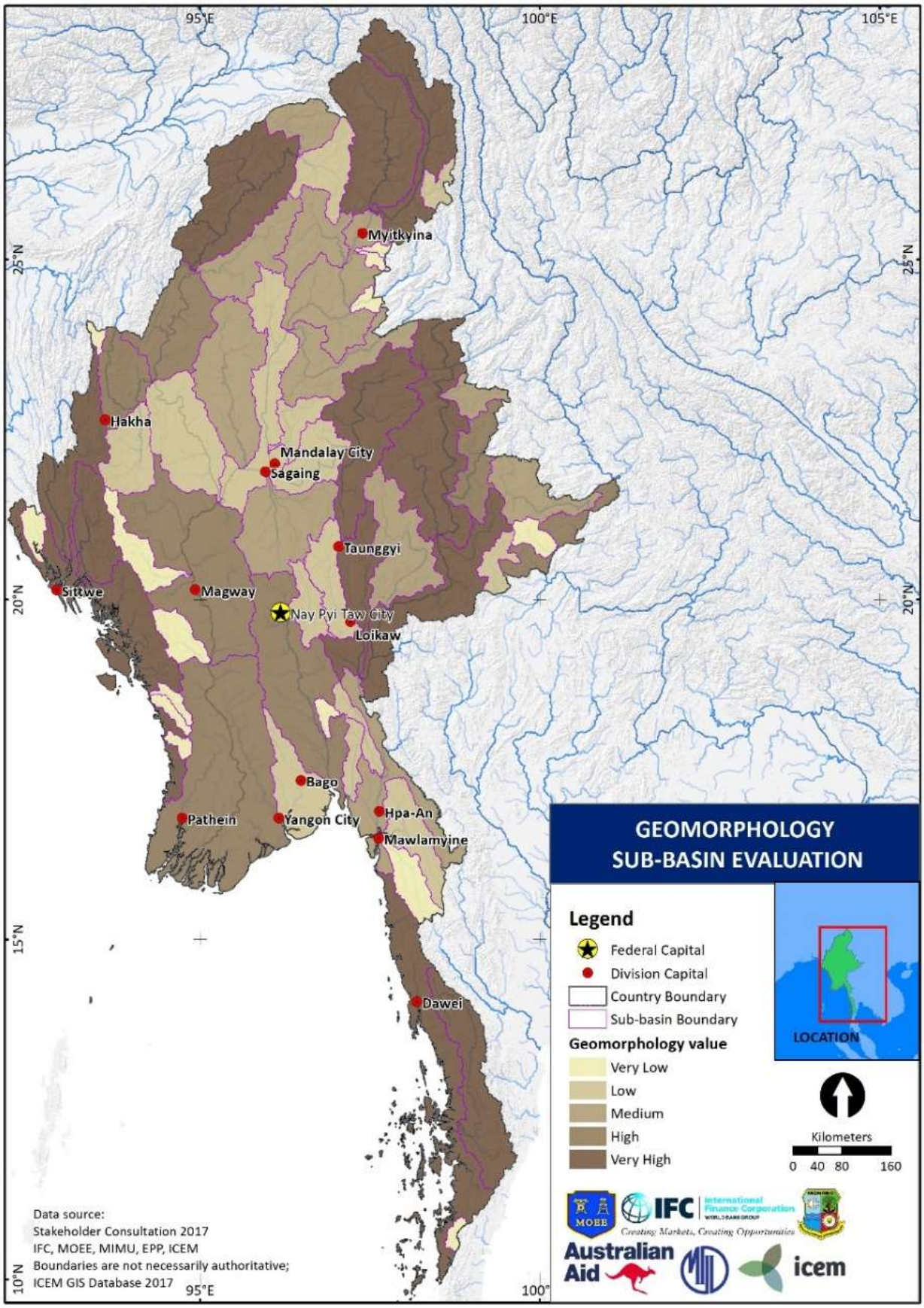


Figure 3.2: Aquatic ecology and fisheries baseline value ratings

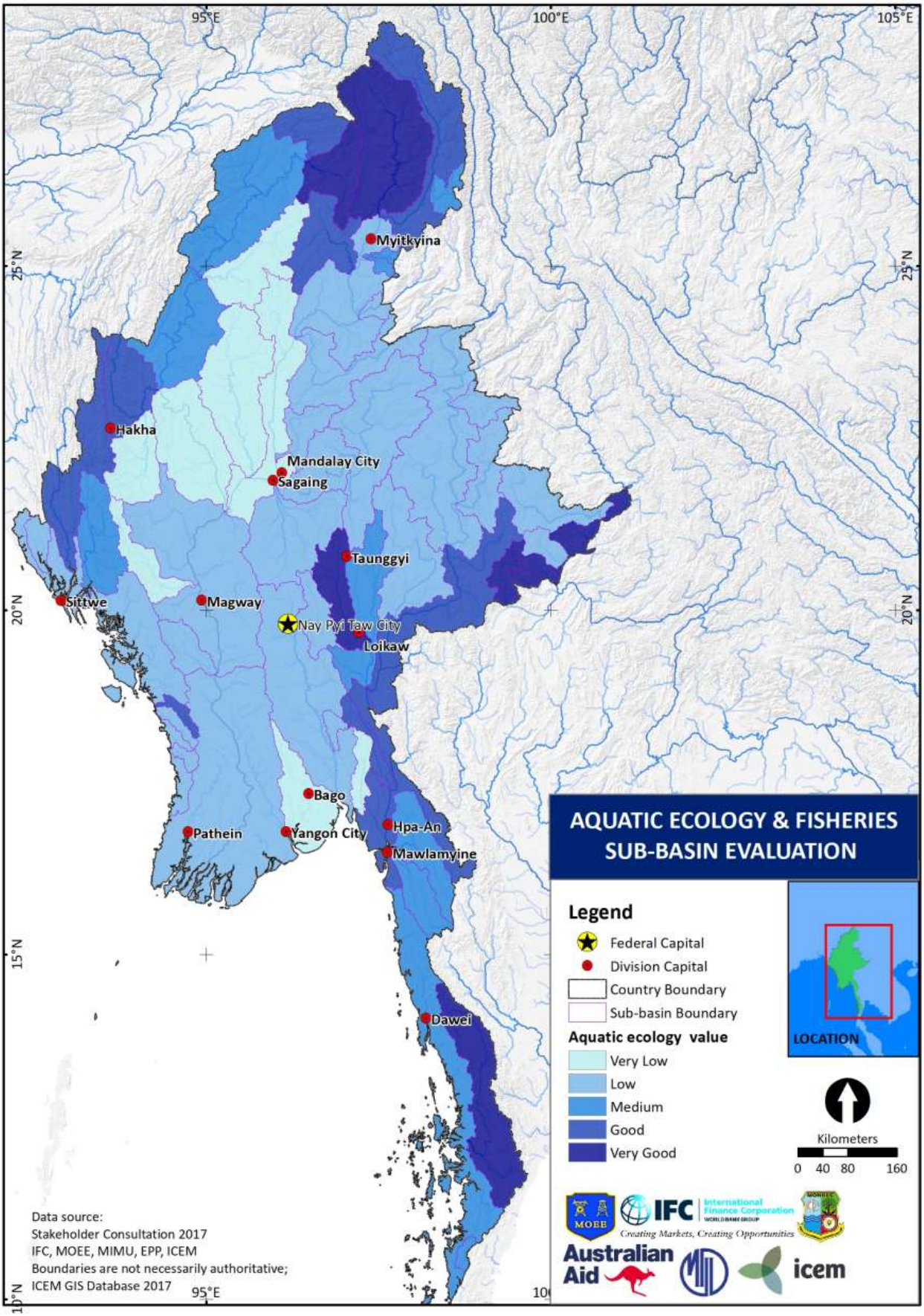


Figure 3.3: Terrestrial biodiversity basely

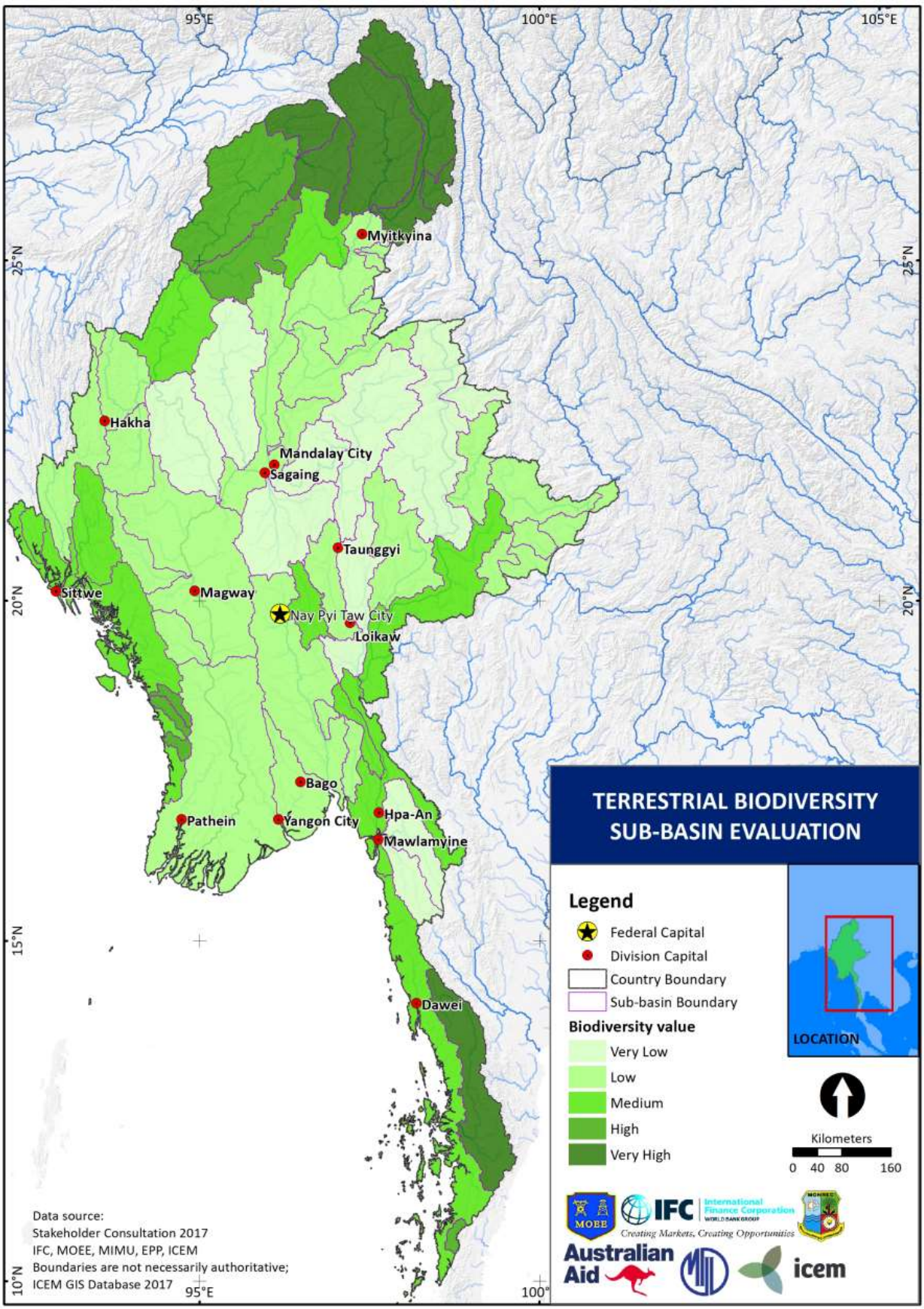


Figure 3.4: Social and livelihoods baseline value ratings

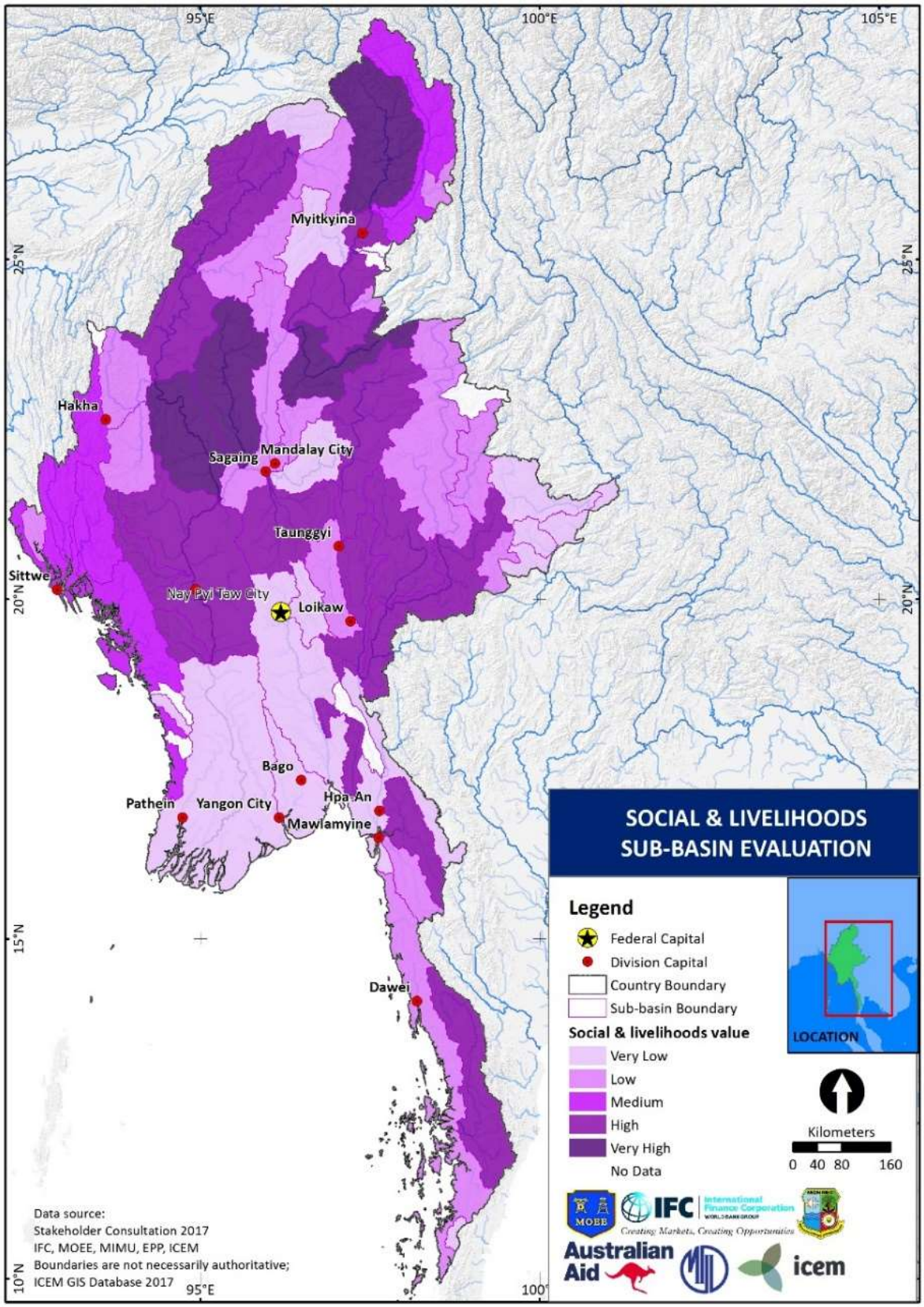


Figure 3.5: Conflict baseline value ratings

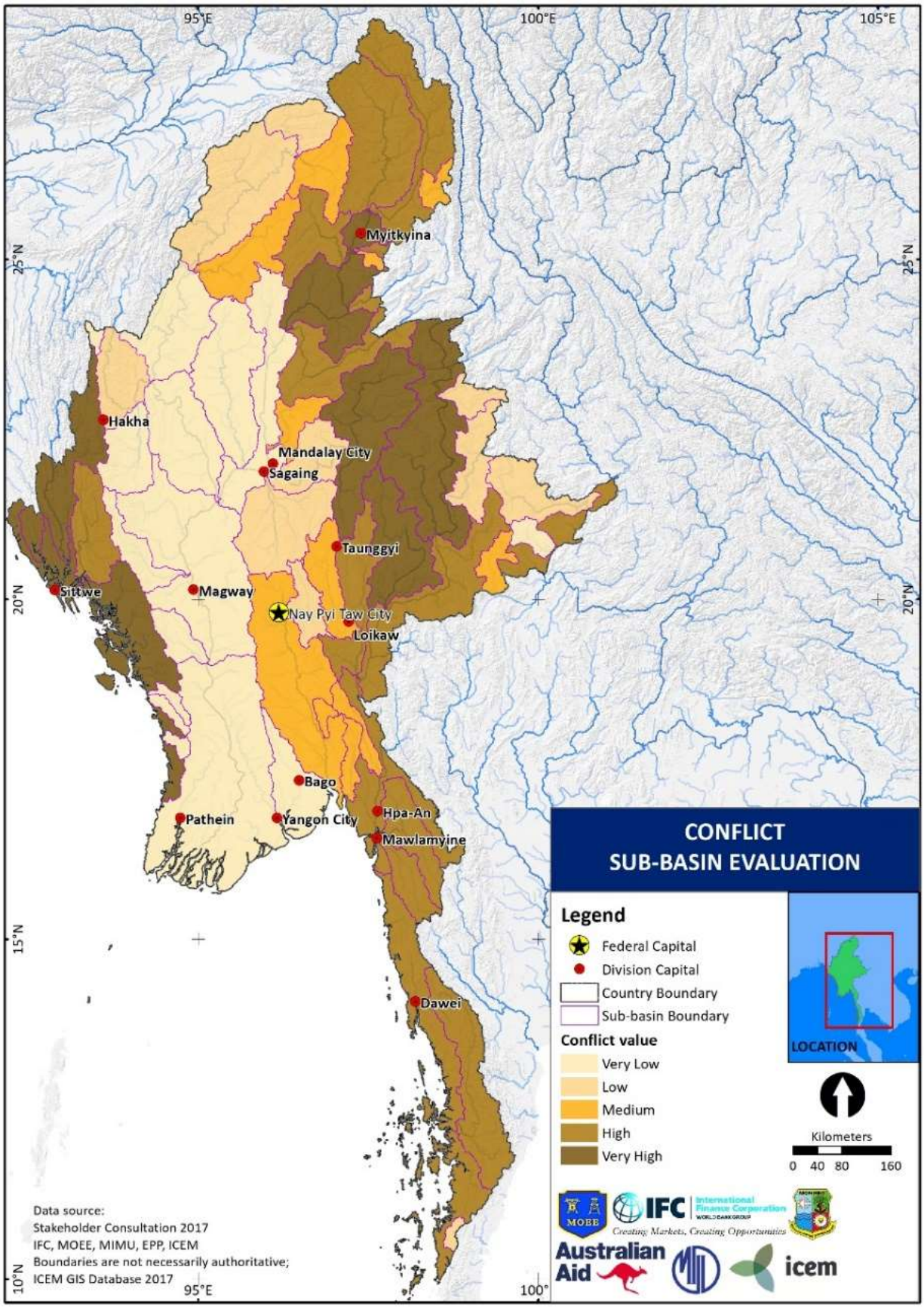


Table 3.1: Baseline value ratings for all themes

No.	Sub-basins	Geomorphology and sediment	EV (Aquatic)	Terrestrial Biodiversity	Social and livelihoods	Conflict
1	Ayeyarwady Lower	4	2	2	4	1
2	Ayeyarwady Middle	2	1	2	2	1
3	Ayeyarwady Upper	3	2	2	4	5
4	Bago	2	1	2	1	1
5	Baluchaung	2	5	2	2	3
6	Barak	1	4	2		1
7	Bawgata	1	2	2	4	3
8	Bilin	2	1	2	4	3
9	Chindwin Headwater 1	3	4	5	1	2
10	Chindwin Headwater 2	2	5	5	2	3
11	Chindwin Lower	2	1	1	5	1
12	Chindwin Middle	4	3	3	4	1
13	Chindwin Upper	5	3	4	4	2
14	Dapein	1	2	2	2	4
15	Delta	4	2	2	1	1
16	Glohong Kra	1	3	4	1	2
17	Kaladan	5	4	2	3	5
18	Kyein Ta Li	1	2	4	N/A	1
19	Lam Pha	2	3	1	4	4
20	Lemro	5	3	3	3	4
21	Ma Gyi Chaung	2	2	2	2	3
22	Mali Creek	1	3	2	N/A	3
23	Mali Hka	5	5	5	5	4
24	Manipur	4	4	2	2	2
25	Mindon	1	2	2	4	1
26	Mone Chaung	1	1	2	4	1
27	Mu	3	1	1	5	1
28	Myet Taw Chaung	1	3	1	2	4
29	Myitnge Lower	2	2	1	1	2
30	Myitnge Upper	5	2	1	4	5
31	Myittha	2	1	2	2	1
32	Nam Hka	4	2	2	2	2
33	Nam Hkoke	2	5	2	2	3
34	Nam Lin	1	2	2	1	1
35	Nam Lwe	3	2	2	1	2
36	Nam Ma	3	2	1	N/A	2
37	Nam Pawn	5	3	1	4	4
38	Nam Teng	1	2	2	4	4
39	Namtabak	3	3	2	N/A	5
40	Naw Chang Hka	2	3	5	2	3
41	Nmae Hka	5	4	5	3	4
42	Other Mekong	4	5	2	1	4
43	Paung Laung	2	2	3	1	2
44	Rakhine Coastal Basins Other	5	2	3	3	5
45	Saing Din Creek	1	2	3	2	5
46	Shweli	3	2	2	5	4
47	Sittaung Other	4	2	2	1	3
48	Tanintharyi	5	5	5	4	4
49	Tanintharyi Coastal Basins Other	5	3	4	2	4
50	Than Dwe	1	2	4	1	1
51	Thanlwin Lower	3	4	3	1	4
52	Thanlwin Middle	5	4	3	4	4
53	Thanlwin Upper	5	2	1	2	5
54	Thatay	1	4	4	N/A	1
55	Tributary with Indawgyi Lake catchment	3	4	3	1	4
56	Uyu	3	1	4	2	3
57	Yunzalin	2	4	3	N/A	3
58	Zawgyi/ Myogyi	3	2	1	4	2

4 SUB-BASIN EVALUATION SUMMARY SHEETS

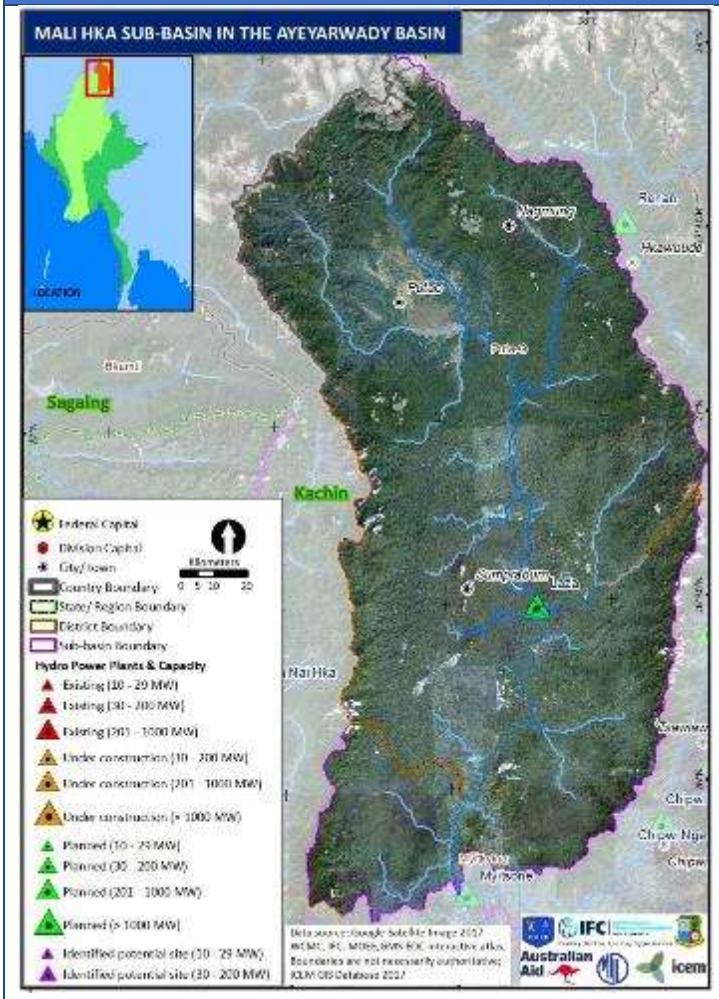
4.1 Ayeyarwady Basin

4.1.1 Mali Hka

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
5	5	5	5	4

Overview



Sub-basin size = relatively large
Location = Kachin state, northern Myanmar, bordering northwestern India

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	14%
Slopes>10 hard rock	65%
Slopes>10 intermed rock	21%

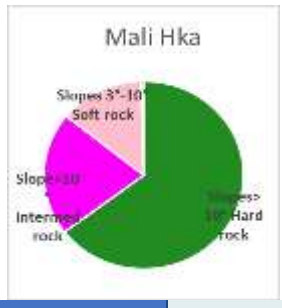
Physical	Area: 23,287 km^2 Average rainfall: 2,524 mm Average sub-basin outflow: 2,693.3 m^3/s
Socio-economic	Population: 74,211 Ethnic diversity: Assamese, Kachins (Singpho), Khun, Lisu, Nua, and Shan Economic activities: + Mining area: 8.9 km^2 (covers 0.04% of sub-basin) + Navigable waterways: None + Land use: Plantation (0%), Agriculture-Rainfed-Single (0.6%)

Administration	States/Regions: Kachin Major town/s: Nagmung, Putao, and Sumprabum
Hydropower development	Existing: 0 Under construction: 0 Planned: 1 (Laza – 1,900 MW) Identified potential site: 0

Geomorphology and sediment	Rating	5

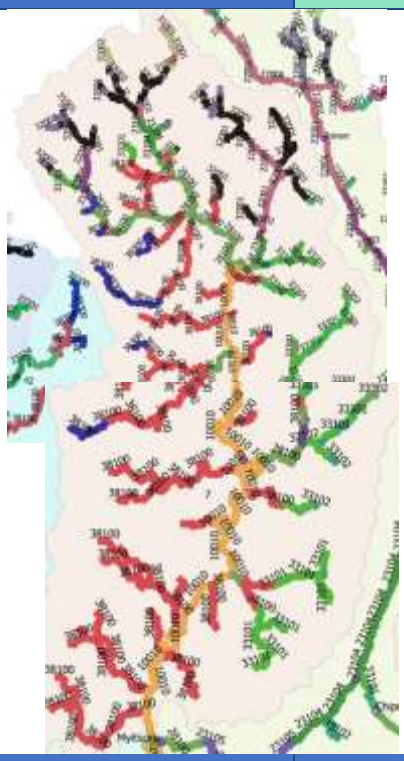
Sub-basin size: very large (88th percentile)

- Headwater sub-basin of the Ayeyarwady straddling Myanmar's eastern, older crystalline strata and the younger, softer rocks in the west.
- The catchment is steep, receives high rates of rainfall, and is likely to provide high volumes of sand into the Ayeyarwady.
- The catchment has low levels of development; although alluvial mining along river banks causes local disturbances, analysis suggests that geomorphic processes are intact in the sub-basin.

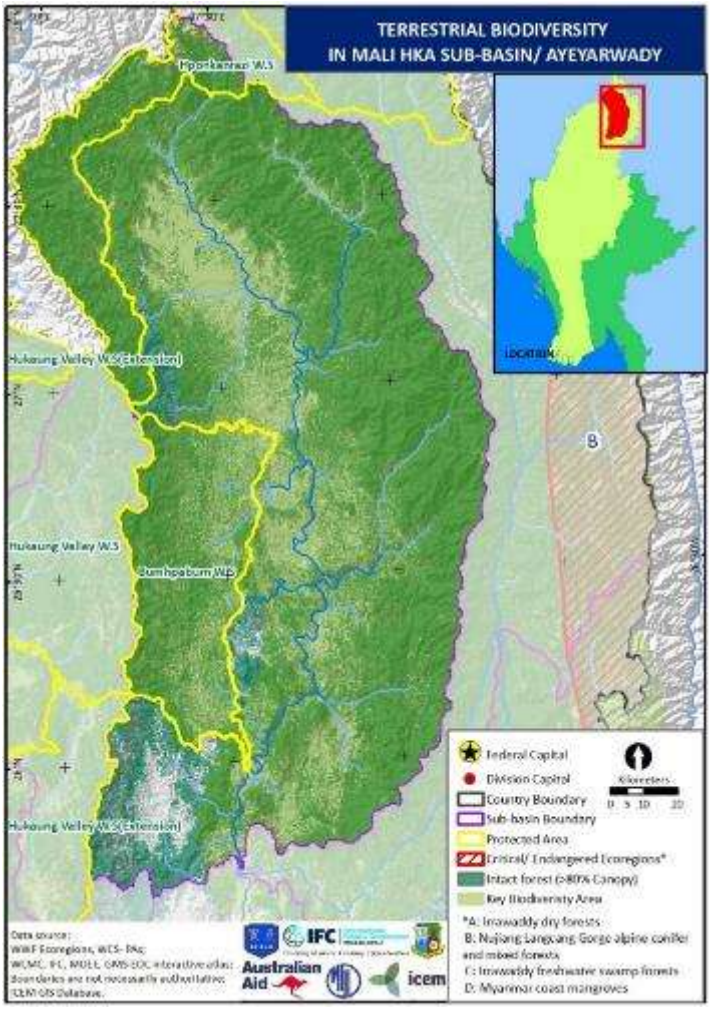


Aquatic ecology and fisheries	Ecological Value Score	5
	Human Pressures score	1

- Mali Hka has a very high ecological value representing the importance of the headwaters of the Ayeyarwady.
- There is a high proportion of rare river reaches – about 30% of the reach lengths and about 60% of karst limestone river reaches in the sub-basin.
- It is recognized as an area of high endemism for fish, as shown by recent surveys carried out around Putao. Long distance migratory species such as *Anguilla bengalensis* reach this sub-basin.
- Confluence with Nmae Hka at Myitsone is very important ecologically and culturally
- The basin has a very low human pressure score indicating good river health, with low loss of forest cover, small population density and little agriculture, mining and roads
- No Hydropower dams at present, though Laza HPP is proposed



Terrestrial biodiversity	Rating	5



Intact forest cover = 70%

KBA = >90%

- One of the most biodiverse sub-basins and a habitat for numerous endemic fish species, tigers, threatened birds, dolphins, and various other species.
- Has several wildlife sanctuaries, including Kponkanrazi, Hukaung Valley, and Bumhpabum.
- Among only six out of 58 sub-basins to receive a biodiversity rating of 5.

Social, livelihoods, and significant sites	Rating	5

- "Own account workers" (livelihood dependent on agriculture/NR) = 27% of the workforce
- Female-headed households = 22% of total households on average
- Avg. % of households owning a TV = 26%
- Ethnic minority groups = Assamese, Kachins (Singpho), Khun, Lisu, Nua, and Shan
- Sub-basin vulnerability rating = 5

Conflict	Rating	4

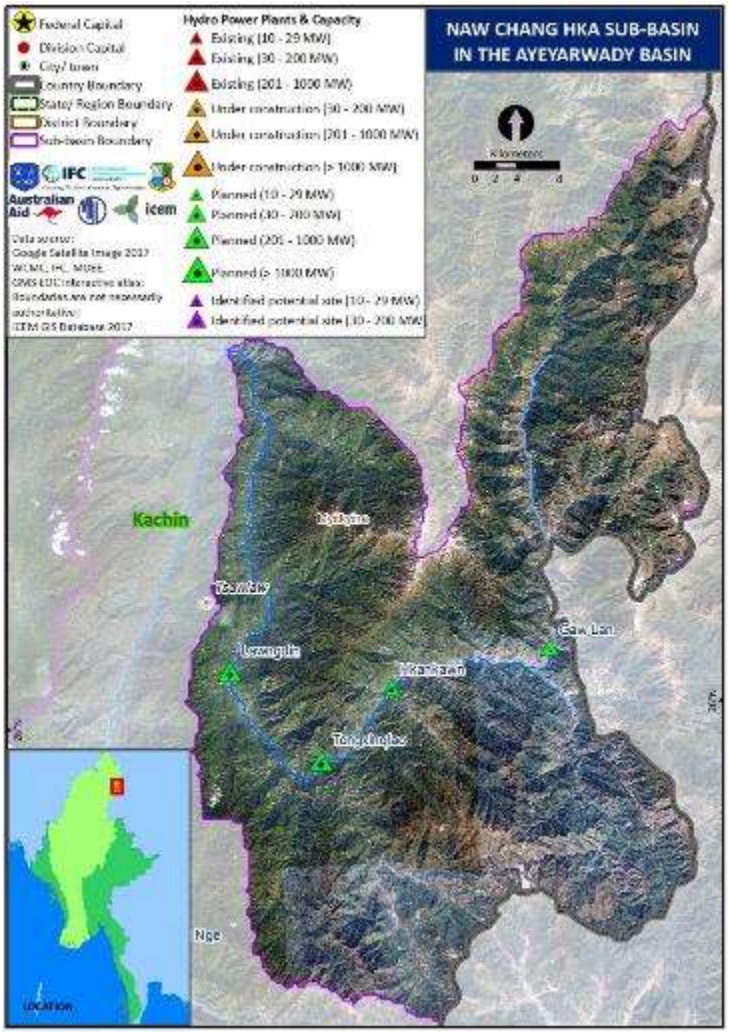
- Armed group presence: KIO in <50% of the sub-basin
- Est. battle deaths (1989-2015) = 70
- Media-reported armed conflict incidents (2012-2016) = 14
- Historical conflict-related displaced people (est.) = 2,140

4.1.2 Naw Chang Hka

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
2	4	5	2	3

Overview



Sub-basin size = small

Location = Kachin state, northeastern Myanmar, bordering China

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	1%
Slopes>10 hard rock	99%

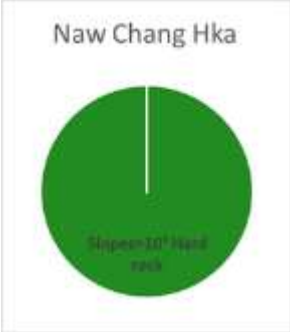
Physical	Area: 2,401 km^2 Average rainfall: 1,540 mm Average sub-basin outflow: 86 m^3/s
Socio-economic	Population: 20,039 Ethnic diversity: Chinese (Han), Kachins (Singpho), Lisu, Shan, and Yi (incl. Chila, Pupiao, and Lolo) Economic activities: + Mining area: 0.5 km^2 (covers 0.1% of sub-basin) + Navigable waterways: None + Land use: Plantation (0%), Agriculture-Rainfed-Single (0.2%)

Administration	States/Regions: Kachin Major town/s:
Hydropower development	Existing: 0 Under construction: 0 Planned: 4 (Gaw Lan – 120 MW, Hkankawn – 140 MW, Lawngdin – 600 MW, Tongxinqiao – 340 MW) Identified potential site: 0

Geomorphology and sediment	Rating	2 (5)

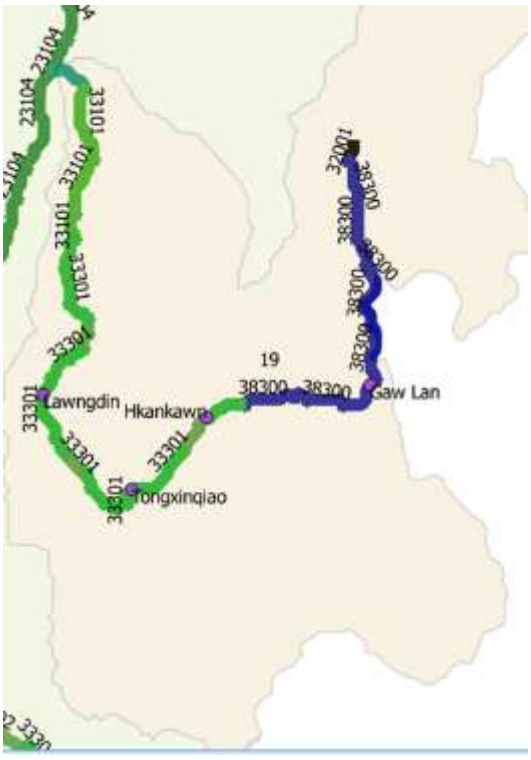
Sub-basin size: small (18th percentile)

- This sub-basin catchment has been extracted from the high-scoring Nmae Hka (geomorphology rating = 5) as it is targeted for hydropower development.
- The headwaters of this very small, steep sub-basin with high rainfall extend into China, but it remains undeveloped and well forested.
- Its small size and low Strahler Order river result in its low geomorphology rating.
- If this area were included in the Nmae Hka, it would not alter the geomorphic rating of 5 for the larger sub-basin.

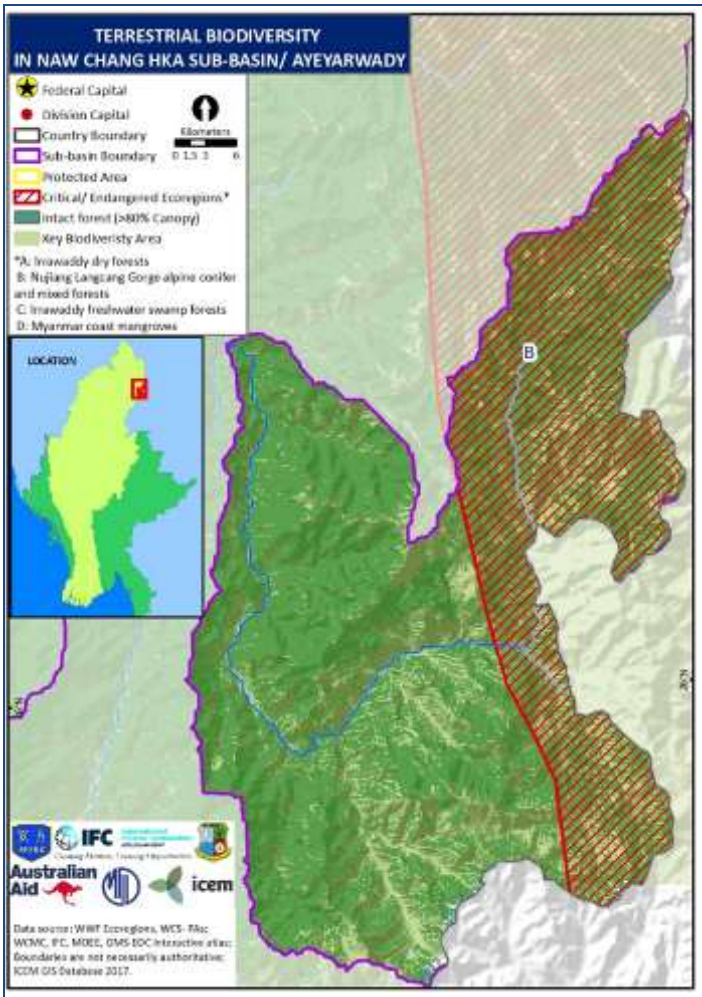


Aquatic ecology and fisheries	Ecological value rating	3
	Human pressure rating	1

- A small tributary of the N'Mae Hka with a mean annual flow estimated at 86 m^3/sec and a minimum flow of 17 m^3/sec.
- A high elevation sub-basin with a fast-flowing river containing many rocks, rapids, and white water.
- Has a high ecological value with six different river reach types of which 4 are very rare, including a medium river, in moist broadleaf forest region at high elevation, with low gradient and a medium river in karst region at high elevation.
- The headwaters of the Ayeyarwady near the Chinese border are likely to be important for endemic species; the upper part of its catchment lies within the Nmae Hka KBA and the Fen-shui-Ling valley.
- Human pressures are low, so the river health status is likely to be good, although there is an open-cast mine in the hills near the watershed with the Shweli sub-basin.
- A cascade of four HPPs has been proposed, namely Gaw Lan, Hkankawn, Lawngdin, and Tongxingiao.



Terrestrial biodiversity	Rating	5



Intact forest cover = >60%

KBA = 99%, a habitat for >20 endemic species including the red panda and snap-nose monkey

Critically endangered ecoregion = 39%, contained significant swaths of the Nujiang Langcang Gorge alpine conifer and mixed forests ecoregion

- Among very few sub-basins that receive both a biodiversity rating of 5 and a red star to signify the importance of protecting this region

Social, livelihoods, and significant sites	Rating	2

- "Own account workers" (livelihood dependent on agriculture/NR) = 26% of the workforce
- Female-headed households = 19% of total households on average
- Avg. % of households owning a TV = 43%
- Ethnic minority groups = Karen, Kayah, and Shan
- Sub-basin vulnerability rating = 2

Conflict	Rating	3

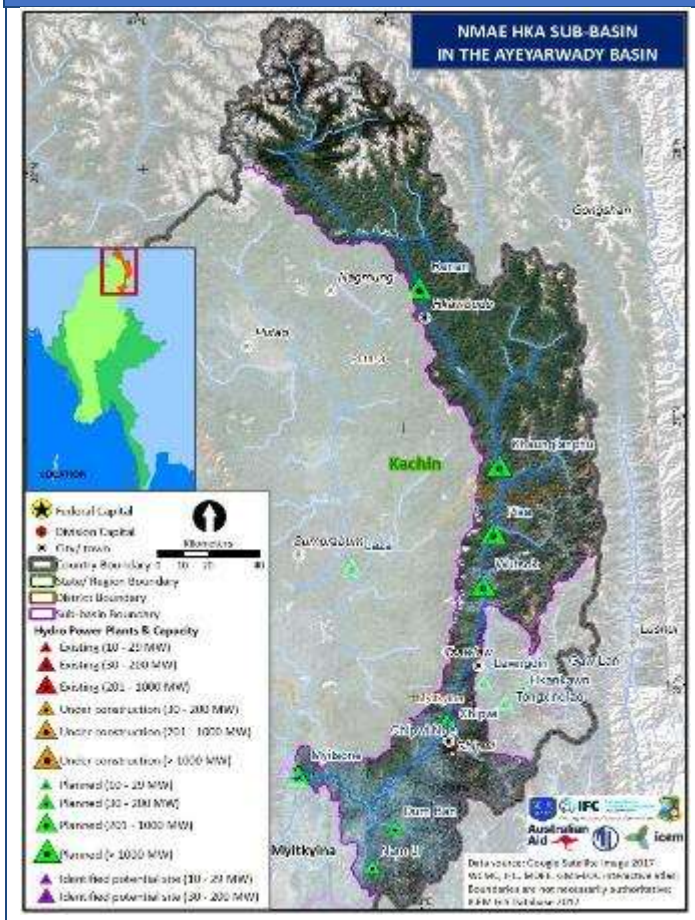
- Armed group presence: armed groups in some of the sub-basin
- Est. battle deaths (1989-2015) = 0
- Media-reported armed conflict incidents (2012-2016) = 1
- Historical conflict-related displaced people (est.) = 2,190
- Small sub-basin likely underestimates vulnerability

4.1.3 Nmae Hka

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
5	4	5	3	4

Overview



Sub-basin size = large
Location = Kachin state, northeastern Myanmar, bordering China

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	1%
Slopes>10 hard rock	99%

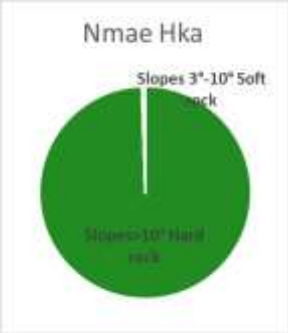
Physical	Area: 17,501 km^2 Average rainfall: 1,540 mm Average sub-basin outflow: 1383.3 m^3/s
Socio-economic	Population: 25,296 Ethnic diversity: Chinese (Han), Kachins (Singpho), Khun, Lisu, Nua, and Tibetans (incl. Hsifan and Chiajung) Economic activities: + Mining area: 10.5 km^2 (covers 0.06% of sub-basin) + Navigable waterways: None + Land use: Plantation (0.1%), Agriculture-Rainfed-Single (0.2%)
Administration	States/Regions: Kachin Major town/s: Chipwi, Hkawbude, Tsawlaw
Hydropower development	Existing: 1 (Chipwi Nge – 99 MW) Planned: 8 (Chipwi – 3,400 MW, Dum Ban – 130MW, Khaunglanphu – 2,700 MW, Myitsone – 6,000MW, Nam Li – 165 MW, Pisa – 2,000 MW, Renan – 1,200 MW, and Wutsok – 1,800 MW)

	Under construction: 0 Identified potential site: 0

Geomorphology and sediment	Rating	5

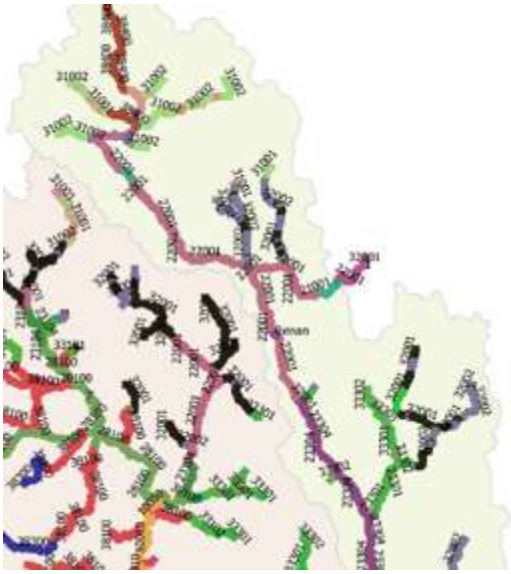
Sub-basin size: large (75th percentile; high Strahler Order & high rainfall)

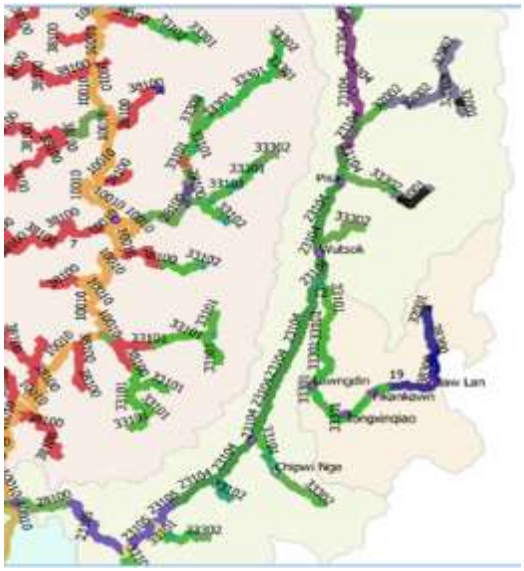
- Situated in the headwaters of the Ayeyarwady, the sub-basin is elevated; the river is steep and transports sand- to boulder-sized sediment.
- The Chipwi sub-catchment is highly developed for mining and forestry, which likely contributes an altered sediment load to the catchment; the catchment is unregulated except for one HPP that regulates <5% of the sub-basin catchment.
- The sub-basin scores highly for all geomorphic indicators resulting in a final rating of "5."
- The assessment excludes the Naw Chang Hka sub-basin, which is evaluated independently; even if included, it would not have altered the final geomorphology rating of the Nmae Hka basin.



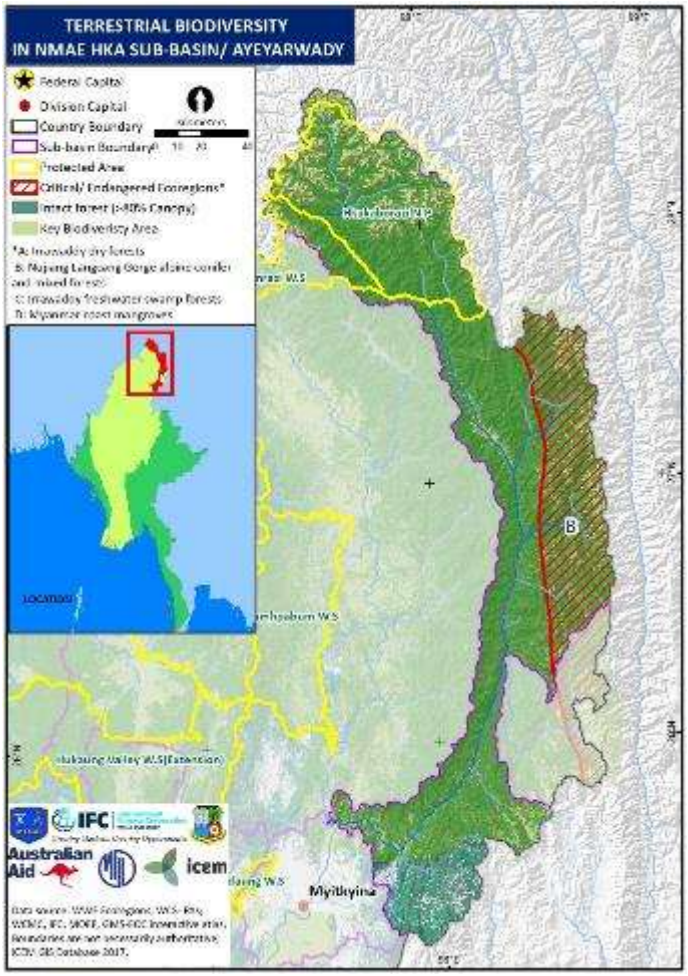
Aquatic ecology and fisheries	Ecological value rating	4
	Human pressure rating	1

- The Nmae Hka has a high ecological value because of the importance of the Ayeyarwady headwaters.
- Nearly 80% of the Nmae Hka's river reaches are rare, with the longest type being large river, in coniferous region, with low gradient; its tributaries mainly have reaches of medium river, in coniferous region, with high gradient.
- Has a different river network shape compared to Mali Hka but is similar to the Upper Thanlwin – with a long narrow mainstem, short tributaries on the left bank, and very little karst reaches (only 9%).
- Recognized area for endemics and important terrestrial KBAs in river valley.
- Confluence with the Mali Hka at the Myitsone is very important ecologically and culturally.
- Pressures are still relatively low, though gold mining is a potential threat to river health, and one HPP is under construction – Chipwe Nge (99 MW) on the Chipwe Hka tributary.





Terrestrial biodiversity	Rating	5



Intact forest cover = >70%

KBA = >90%

- A habitat for more than 20 endemic species including the red panda and snap-nose monkey

Protected area = >27%

- Includes the Hkakaborazi National Park and the Hponkanrazi Wildlife Sanctuary

Critically endangered ecoregions = 20% of the Nujiang Langcang Gorge alpine conifer and mixed forests ecoregion

- One of the only sub-basins that receives both a top biodiversity rating of 5 and a red star to signify the importance of protecting this region.

Social, livelihoods, and significant sites	Rating	3

- "Own account workers" (livelihood dependent on agriculture/NR) = 25% of the workforce
- Female-headed households = 16% of total households on average
- Avg. % of households owning a TV = 16%
- Ethnic minority groups = Kachins (Singpho), Khun, Lisu, Nua, and Tibetans (incl. Hsifan and Chiajung)
- Sub-basin vulnerability rating = 3

Conflict	Rating	4

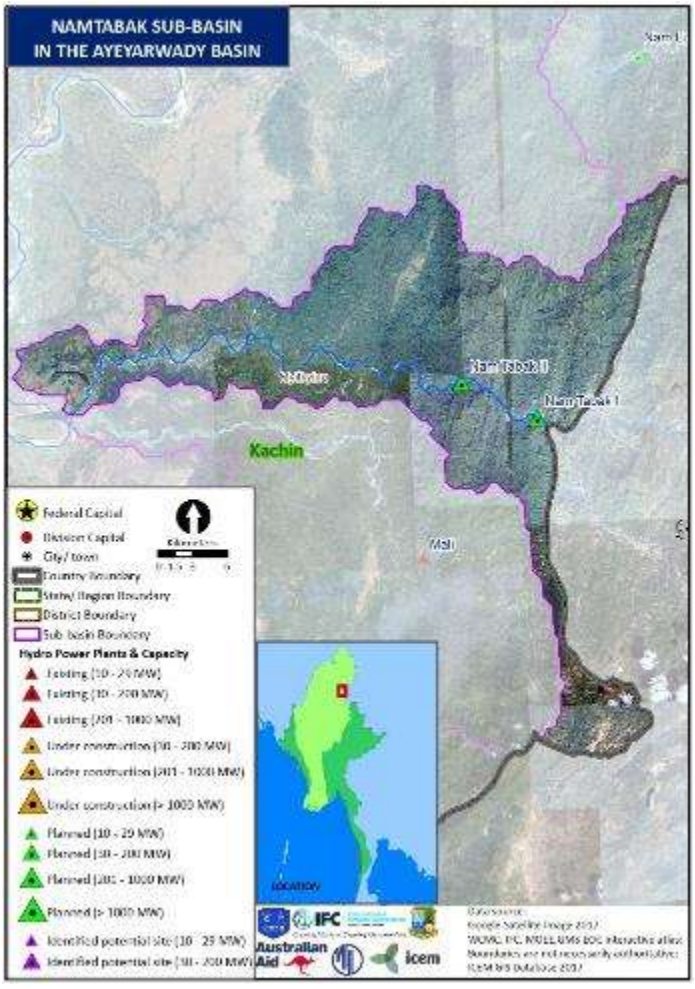
- Armed group presence: influential in much of the sub-basin, including both opposed to and supportive of the Myanmar army (medium)
- Est. battle deaths (1989-2015) = 6
- Media-reported armed conflict incidents (2012-2016) = 11
- Historical conflict-related displaced people (est.) = 13,053

4.1.4 Namtabak

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
3	3	2	N/A	5

Overview



Sub-basin size = smallest in the country
Location = Kachin state, northeastern Myanmar, bordering China

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	39%
Slopes<3 Elev>30m	55%
Slopes>10 hard rock	6%

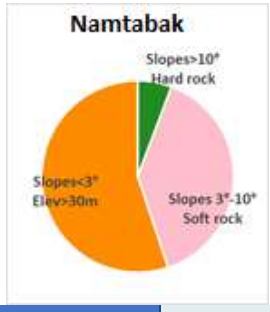
Physical	Area: 718 km^2 Average rainfall: 1,910 mm Average sub-basin outflow: 115.7 m^3/s
Socio-economic	Population: N/A Ethnic diversity: Kachins (Singpho), Khamti, Lhao Vo, and Zaiwa Economic activities: + Mining area: 0.3 km^2 (covers 0.04% of sub-basin) + Navigable waterways: None + Land use: Plantation (0.1%), Agriculture-Rainfed-Single (7.3%), Irrigated-Single (0.1%), Irrigated-Double (1.6%), Irrigated-Triple (0.1%)
Administration	States/Regions: Kachin Major town/s:

Hydropower development	Existing: 0 Under construction: 0 Planned: 2 (Nam Tabak I – 141 MW, Nam Tabak II – 144 MW) Identified potential site: 0

Geomorphology and sediment	Rating	1

Sub-basin size: smallest in the analysis (low Strahler Order 2)

- Has similar characteristics as Mali Creek as it drains the western flanks of the Shan plateau.
- Its headwaters extend into China where two cascade hydropower schemes have been developed on its major tributaries.
- Within Myanmar, the river is largely undeveloped and forested.
- The low geomorphic rating reflects its small size, low Strahler Order, and upstream regulation, including de-watered areas leading to relatively low connectivity and input of water ratings.

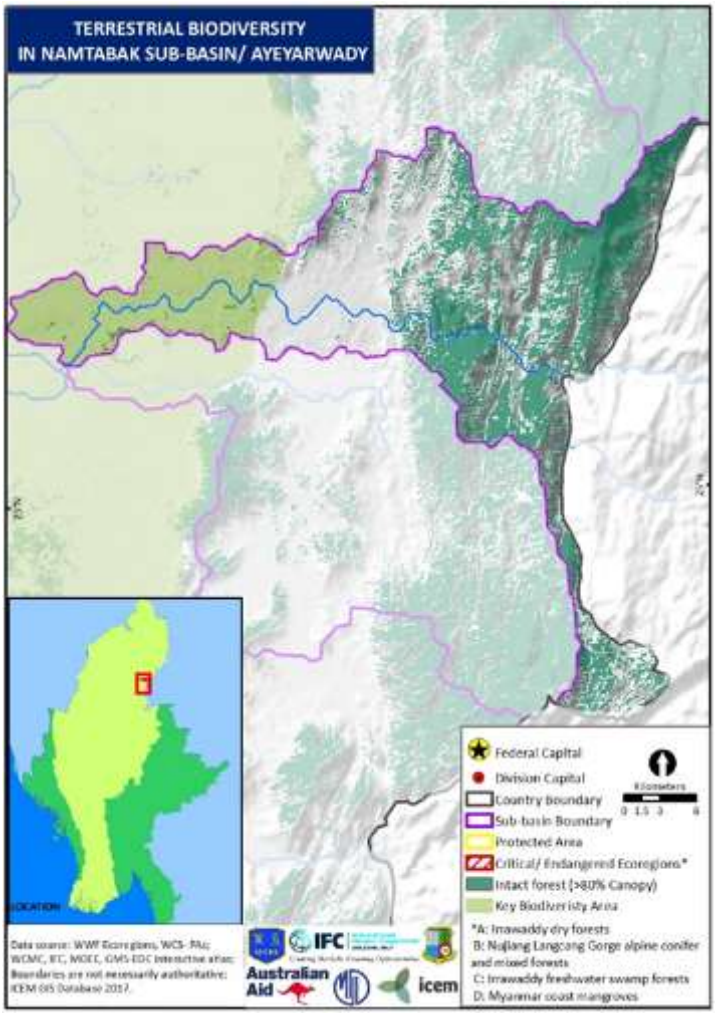


Aquatic ecology and fisheries	Ecological value rating	3
	Human pressure rating	2

- A small tributary on the east bank of the Ayeyarwady, 110 km downstream from the Mali Hka and N'Mae Hka confluence.
- The mean annual flow at the confluence with the mainstem is 112 m^3/sec.
- It has 114 km of large- and medium-sized river reaches, mainly in moist broadleaf forest region at low elevation, with low gradient. Four of the six river reach types found in the sub-basin are rare, making up 61% of the river reach lengths. There is no karst limestone.

- The Myitkyina-Nandebad-Talawgyi KBA – listed as data-deficient – covers the lower reaches of the basin. There is some pressure on river health from mining and agriculture, but rural populations are quite low.
- Two hydropower dams are proposed on this tributary.

Terrestrial biodiversity	Rating	2



Intact forest cover = 34%

KBA = 19%

- The Myitkyina-Nandebad-Talawgyi KBA

Protected areas = 0%

Critically endangered ecoregions = 0%

Social, livelihoods, and significant sites	Rating	N/A
Ethnic minority groups = Kachins (Singpho), Khamti, Lhao Vo, and Zaiwa		
Conflict	Rating	4

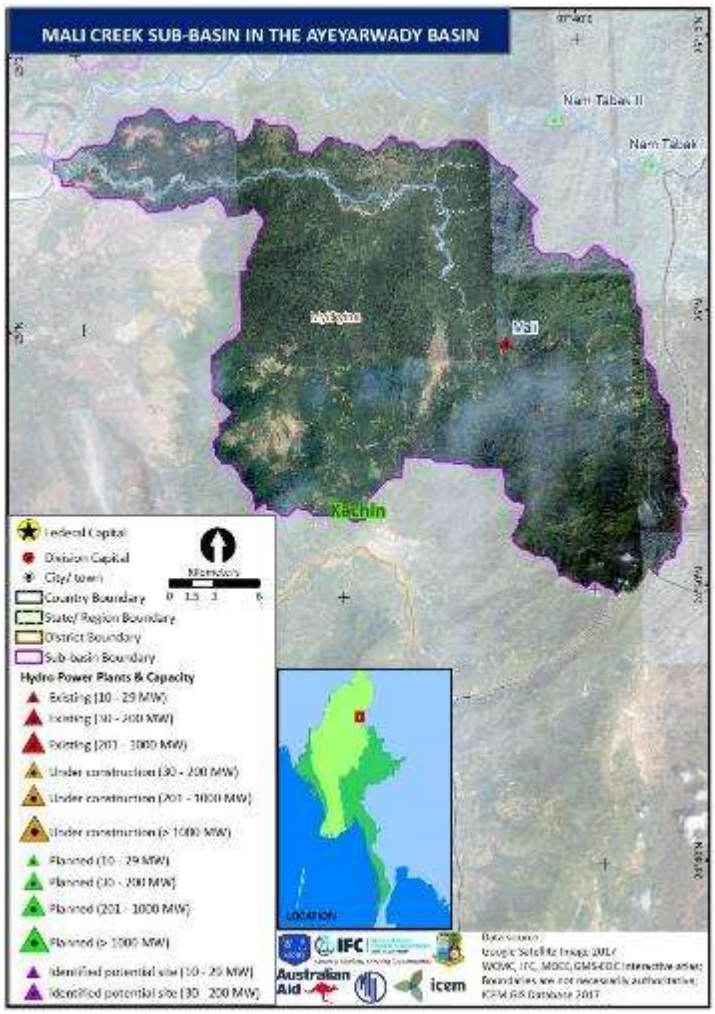
- Armed group presence: KIO in much of the sub-basin, including areas under KIO control
- Est. battle deaths (1989-2015) = 1
- Media-reported armed conflict incidents (2012-2016) = 4
- Historical conflict-related displaced people (est.) = 3,936

4.1.5 Mali Creek

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
1	3	2	N/A	3

Overview



Sub-basin size = second-smallest in Myanmar
Location = Kachin state, northern Myanmar, bordering China

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	59%
Slopes>10 hard rock	41%

Physical	Area: 719 km^2 Average rainfall: 1,828 mm Average sub-basin outflow: 51.5 m3/s
Socio-economic	Population: N/A Ethnic diversity: Singpho, Lhao Vo, and Khamti Economic activities: + Mining area: 0.2 km^2 (covers 0.03% of sub-basin) + Navigable waterways: None + Land use: Plantation (0.2%), Agriculture-Rainfed-Single (5.2%), Irrigated-Single (0.1%), Irrigated-Double (1.9%)
Administration	States/Regions: Kachin Major town/s: Nil

Hydropower development	Existing: 1 (Mali – 11 MW) Under construction: 0 Planned: 0 Identified potential site: 0

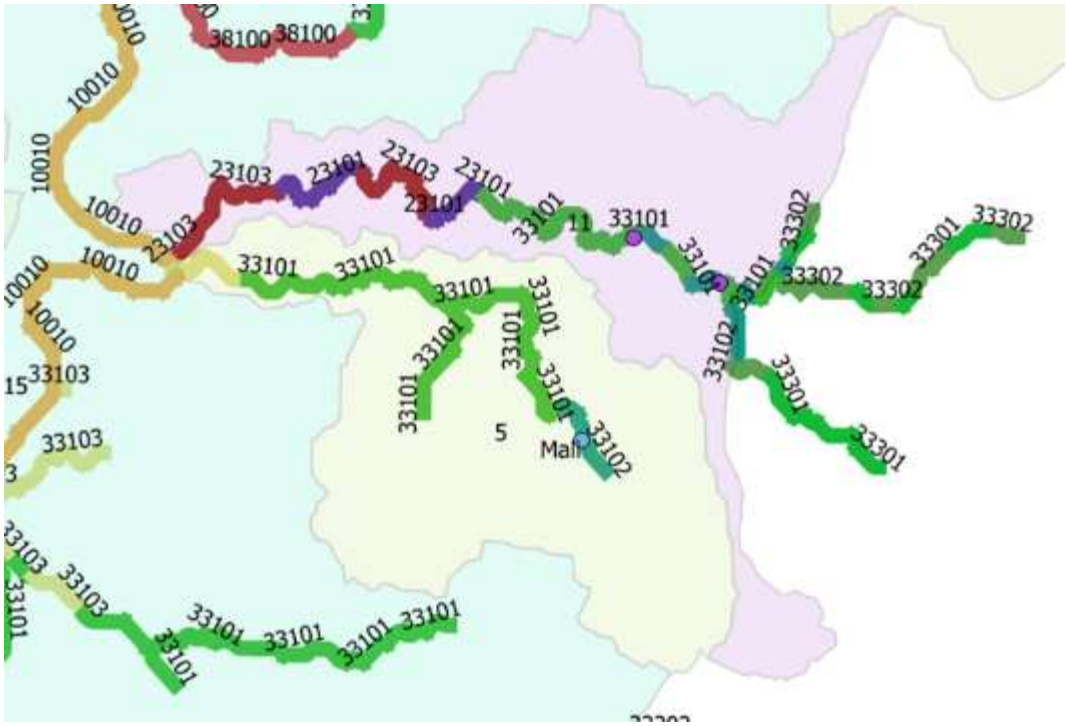
Geomorphology and sediment	Rating	1

Sub-basin size: very small (2nd percentile; low order rivers)

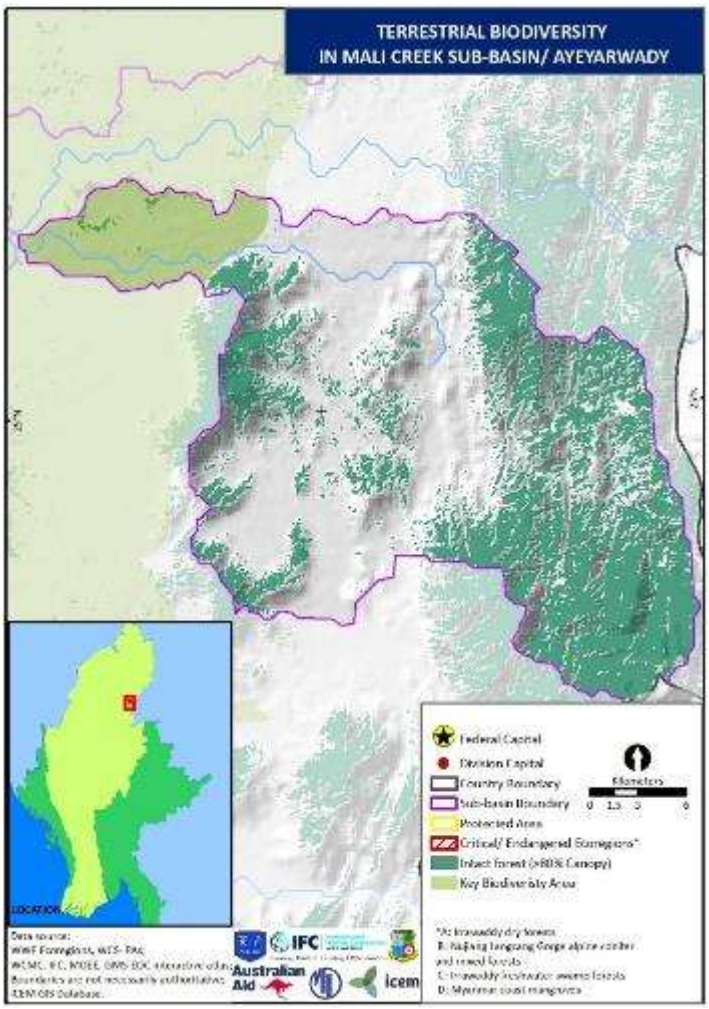
- Drains the western edge of the Shan plateau and discharges to the Upper Ayeyarwady.
- The HPP development has disrupted the connectivity of the sub-basin, trapped sediment, regulated the flow, and resulted in a >5 km reach of the river being de-watered.
- Its small size, combined with its highly regulated nature, contributes to the resultant low geomorphic rating.

Aquatic ecology and fisheries	Ecological value rating	3
	Human pressure rating	2

- A very small sub-basin on the east bank of the Ayeyarwady; the confluence is immediately downstream of the Namtamphak with a mean annual flow of 52 m^3/sec.
- It has 52 km of two river reach types: medium river, in moist broadleaf forest region at low elevation, with both low and high gradient; the second type is rare with 6 km of it.
- Similar to the Namtamphak, the lower reaches lie within the Myitkyina-Nandebad-Talawgyi KBA.
- There is a small run-of-river hydropower plant in the upper reaches, with a 1 km reservoir and very low impact rating on aquatic ecology.



Terrestrial biodiversity	Rating	2



Intact forest cover = 33%

KBA = 9%

Protected area = 0%

Critically endangered ecoregions = 0%

Social, livelihoods, and significant sites	Rating	N/A
Ethnic minority groups = Kachins (Singpho), Lhao Vo, and Khamti		
Conflict	Rating	3

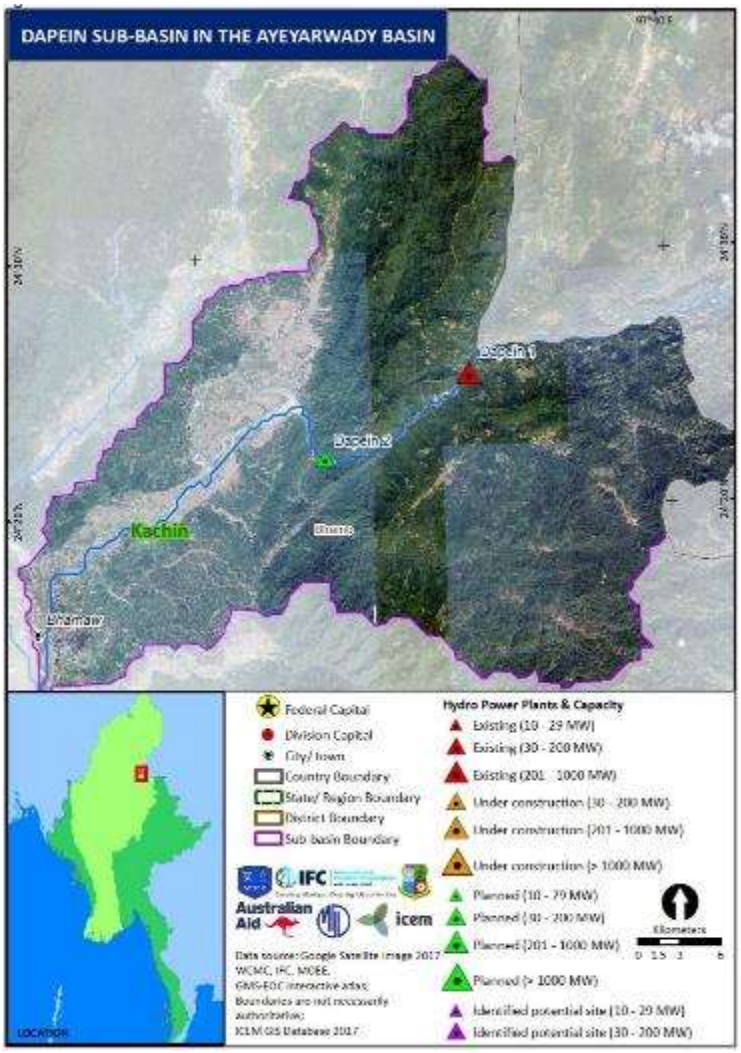
- Armed group presence: Kachin Independence Army (KIO) in much of the sub-basin, including areas under KIO control
- Est. battle deaths (1989-2015) = 3
- Media-reported armed conflict incidents (2012-2016) = 4
- Historical conflict-related displaced people (est.) = 4,003
- NB: small sub-basin and degree of KIO control (vs. contestation) likely underestimates vulnerability

4.1.6 Dapein

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
1	3	2	2	4

Overview



Sub-basin size = relatively small
Location = Kachin state, northeastern Myanmar

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	5%
Slopes<3 Elev>30m	28%
Slopes>10 hard rock	67%

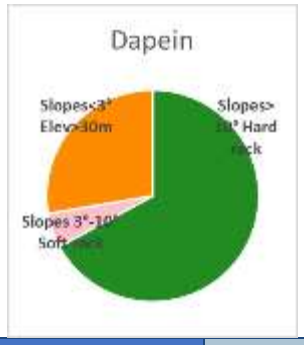
Physical	Area: 1,235 km^2 Average rainfall: 1,686 mm Average sub-basin outflow: 372.8 m^3/s
Socio-economic	Population: 62,914 Ethnic diversity: Kachins (Singpho) and Shan Economic activities: + Mining area: No + Navigable waterways: None + Land use: Plantation (1.0%), Agriculture-Rainfed-Single (6.8%), Flood Plain-Single (0.7%), Flood Plain-Double (0.3%), Irrigated-Double (5.5%)

Administration	States/Regions: Kachin Major town/s: Bhamo
Hydropower development	Existing: 1 (Dapein 1 – 240 MW) Under construction: 0 Planned: 1 (Dapein 2 – 140 MW) Identified potential site: 0

Geomorphology and sediment	Rating	1

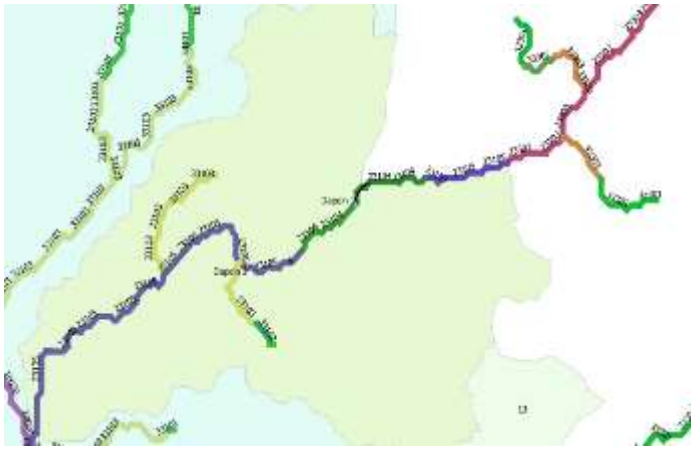
Sub-basin size: small (10th percentile)

- The Dapein River rises in China, where it has been substantially developed for hydropower.
- Drains the western rim of the Shan Plateau flowing through the foothills and large depositional area before joining the Ayeyarwady near Bhamo.
- Its high degree of regulation (>90% of catchment is upstream of existing HPP) and extensive de-watered river reaches have disrupted the connectivity of the river, reduced sediment passage, and altered the flow regime, resulting in a low overall rating.



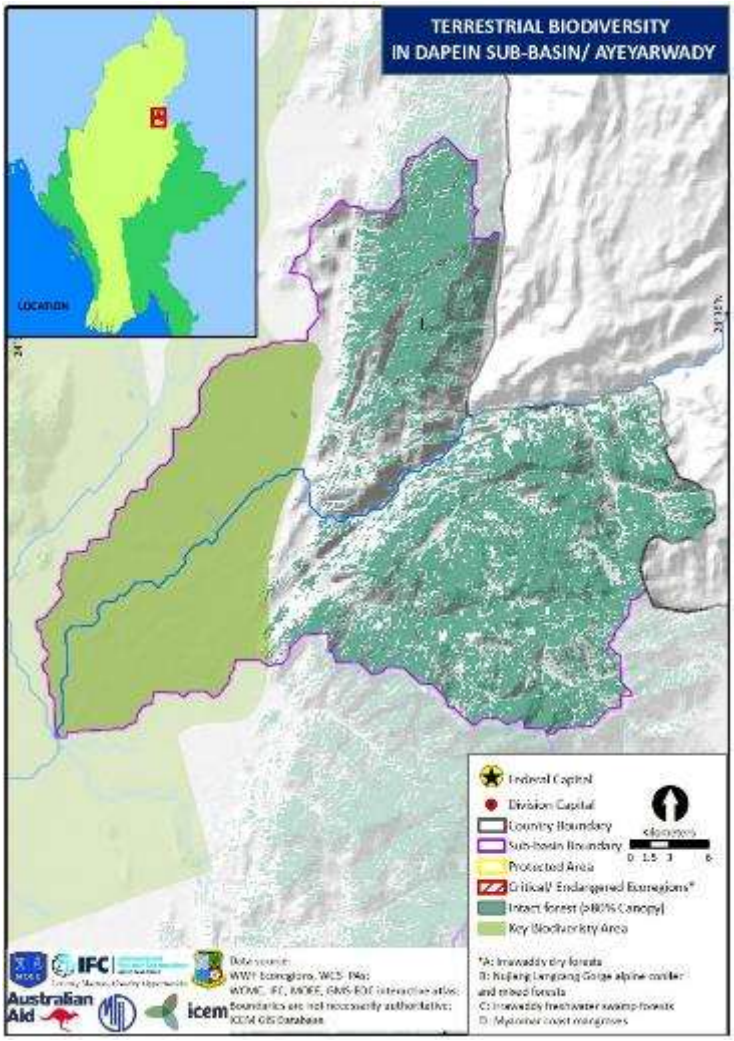
Aquatic ecology and fisheries	Ecological value rating	3
	Human pressure rating	3

- The Dapein river has a relatively small sub-basin flowing in from China on the east bank of the Ayeyarwady. The flows at the confluence are about 370 m^3/sec.
- It has 62 km of river reach (levels 2 and 3) with nine river reach types of which six are rare (76% of the lengths). The type with the longest sections is large river, in moist broadleaf forest region at low elevation, with floodplains and sediment. It does not flow through karst limestone.
- The 96 inns KBA covers the lower part of the sub-basin.



- The main human pressures on the river include the cascade of dams in China and the Dapein 1 HPP (240 MW) built about 50 km upstream of the confluence with the Ayeyarwady.

Terrestrial biodiversity	Rating	2



Intact forest cover = 40%

KBA = 30%

- An important habitat for the endangered Irrawaddy dolphin and several other species of fish.

Social, livelihoods, and significant sites	Rating	2

- "Own account workers" (livelihood dependent on agriculture/NR) = 23% of the workforce
- Female-headed households = 32% of total households on average
- Avg. % of households owning a TV = 60%
- Ethnic minority groups = Kachins (Singpho) and Shan
- Sub-basin vulnerability rating = 2

Conflict	Rating	4

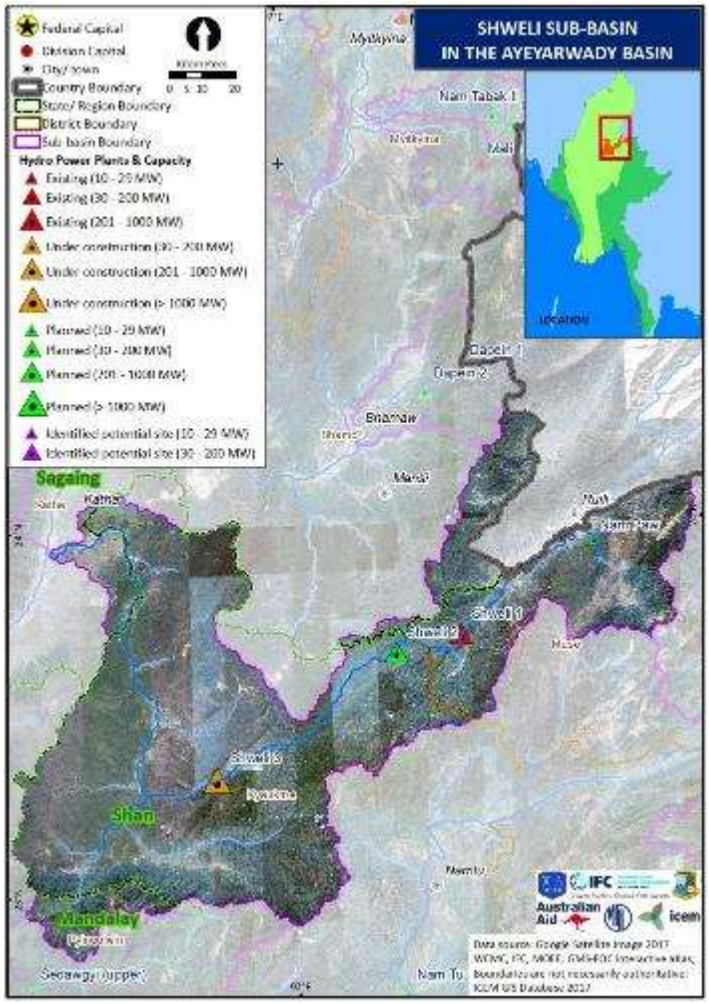
- Armed group presence: KIO in much of the sub-basin, including areas under KIO control
- Est. battle deaths (1989-2015) = 1
- Media-reported armed conflict incidents (2012-2016) = 7
- Historical conflict-related displaced people (est.) = 9,785
- Casualties appear to account for 2011 conflict close to Dapein HPP, and could underestimate vulnerability

4.1.7 Shweli

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
3	2	2	5	4

Overview



Sub-basin size = medium

Location = Kachin and Shan states, eastern Myanmar, bordering China

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	10%
Slopes 3-10 soft rock	23%
Slopes<3 Elev>30m	21%
Slopes>10 hard rock	46%

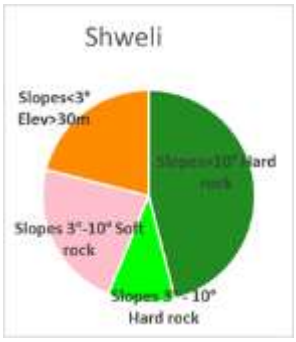
Physical	Area: 13,141 km^2 Average rainfall: 1,533 mm Average sub-basin outflow: 1,020.2 m^3/s
Socio-economic	Population: 328,567 Ethnic diversity: Kachins (Singpho), Palaung, and Shan Economic activities: + Mining area: 16.2 km^2 (covers 0.12% of sub-basin) + Navigable waterways: None + Land use: Plantation (0.2%), Agriculture-Rainfed-Single (5.4%), Irrigated-Double (1.2%), Irrigated-Triple (0.1%)
Administration	States/Regions: Kachin, Mandalay, Sagaing, and Shan Major town/s: Mongmit and Mabein

Hydropower development	Existing: 1 (Shweli 1 – 600 MW) Under construction: 1 (Shweli 3 – 1,050 MW) Planned: 2 (Nam Paw – 20 MW, Shweli 2 – 520 MW) Identified potential site: 0

Geomorphology and sediment	Rating	3

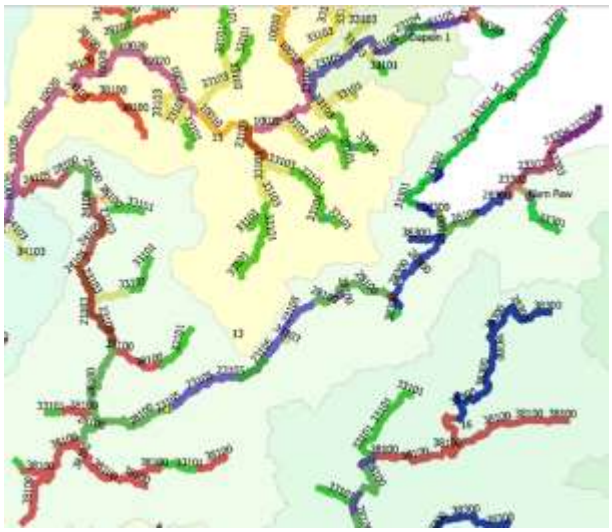
Sub-basin size: large (63rd percentile; high Strahler Order)

- Drains the western Shan plateau and foothills before flowing through an alluvial plain and joining the Ayeyarwady.
- Heavily developed with extensive mining and agriculture activities as well as existing hydropower projects in China and Myanmar.
- The lower reaches of the river have shown geomorphic response to the flow and sediment changes with substantial straightening of the main channel upstream of the confluence since the 1980s.
- The sub-basin has large water and sediment inflows as well as a high Strahler Order, but a high level of regulation reduced its final geomorphic rating.



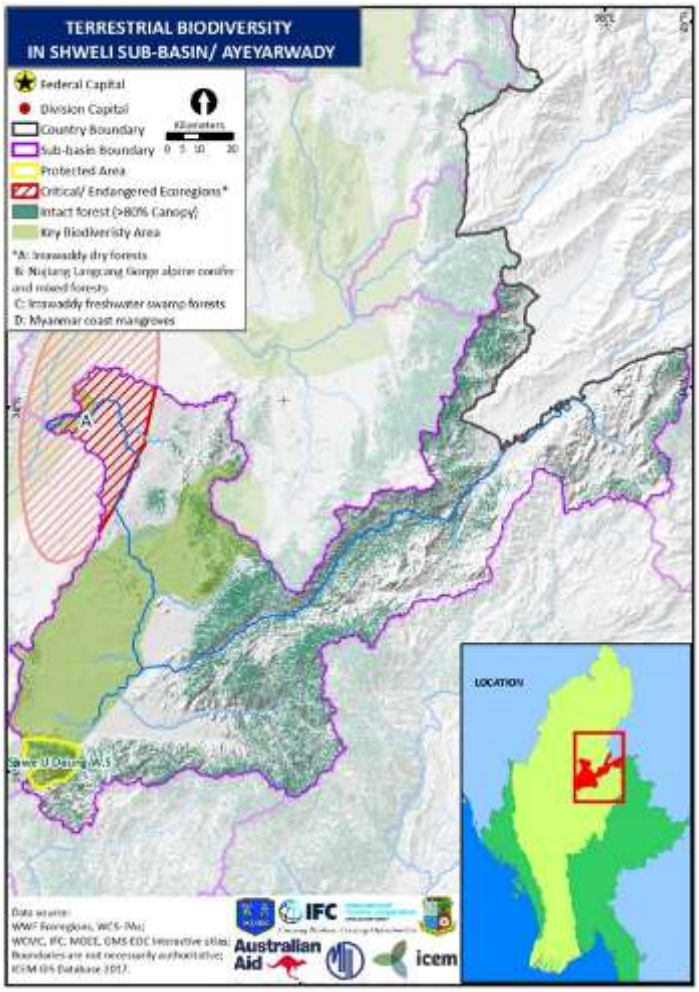
Aquatic ecology and fisheries	Ecological value rating	2
	Human pressure rating	3

- The Shweli River rises in China; after flowing in a southwest direction, it takes a turn to the north before its confluence with the Ayeyarwady about 380 kms downstream from the Myitsone.
- Its mean annual flow is 1,018 m^3/sec and minimum flow is estimated at 207 m^3/sec at the confluence.
- With 750 kilometers within China and Myanmar, it has 17 river reach types of which 10 are rare, representing about 44% of the length. About 47% of its river reach length flows through limestone karst.
- The sub-basin is not remarkable for endemic or threatened aquatic species, and there are no aquatic KBAs.



- The Shweli River has been extensively modified and regulated by at least eight HPPs in cascade in China. In Myanmar, there is one existing HPP (Shweli 1 – 600 MW) and one under construction (Shweli 3 – 1,050 MW). Shweli 3 is lowest in the sub-basin but is considered to have the highest impact, especially on connectivity; with a much longer reservoir (65 km), it will flood a larger length of rare river reaches. A third HPP, Shweli 2, is proposed between Shweli 1 and 3.

Terrestrial biodiversity	Rating	2



Intact forest cover = 19%

KBA = 22%

- A habitat for the endangered Irrawaddy dolphin and a breeding ground for other important fish species.

Protected area = 1.5%; the Shwe U Daung Wildlife Sanctuary

Critically endangered ecoregion = 6%; the Irrawaddy dry forest ecoregion prior to human intervention

Social, livelihoods, and significant sites	Rating	5

- "Own account workers" (livelihood dependent on agriculture/NR) = 29% of the workforce
- Female-headed households = 27% of total households on average
- Avg. % of households owning a TV = 50%
- Ethnic minority groups = Kachins (Singpho), Palaung, and Shan
- Sub-basin vulnerability rating = 5

Conflict	Rating	4

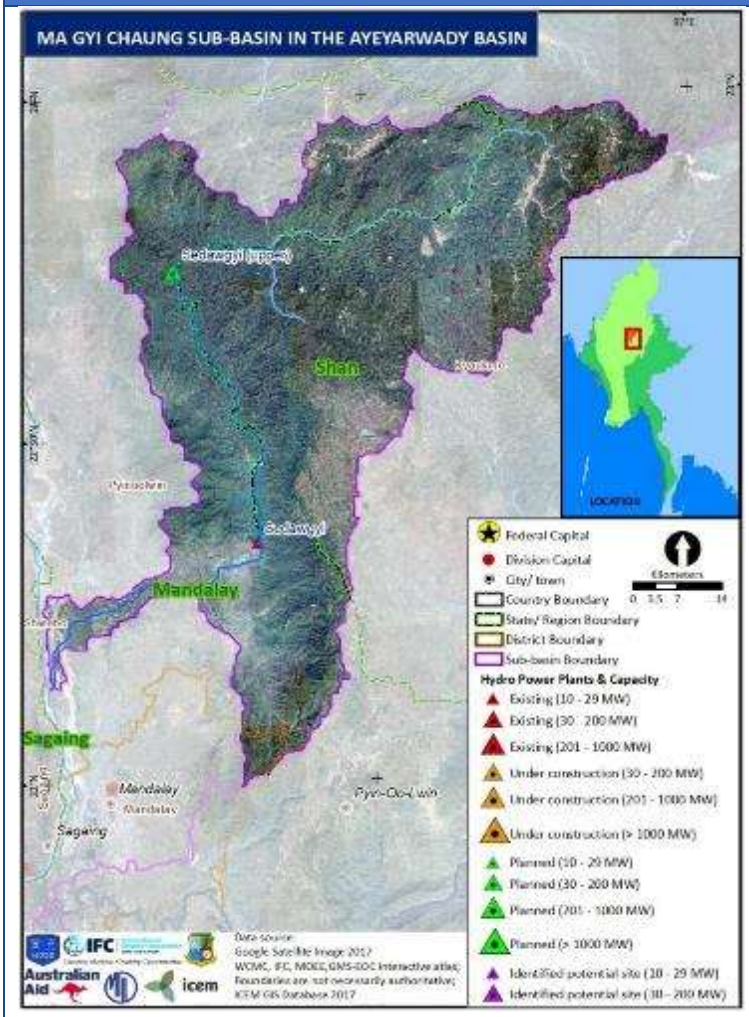
- Armed group presence: Multiple armed groups in much of the sub-basin, actively contesting territory with the Myanmar Army (very high)
- Est. battle deaths (1989-2015) = 40
- Media-reported armed conflict incidents (2012-2016) = 178
- Historical conflict-related displaced people (est.) = 7,108
- Conflict in this sub-basin has been extremely high (more than 10 incidents 2012-2016), thus vulnerability is likely underestimated

4.1.8 Ma Gyi Chaung

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
2	2	2	2	3

Overview



Sub-basin size = relatively small
Location = Shan state in the heart of Myanmar

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	14.7%
Slopes 3-10 soft rock	8.8%
Slopes<3 Elev>30m	0.5%
Slopes>10 hard rock	75.9%

Physical	Area: 4,341 km^2 Average rainfall: 1,802 mm Average sub-basin outflow: 166.7 m3/s
Socio-economic	Population: 167,149 Ethnic diversity: Palaung, Shan Economic activities: + Mining area: 9 km^2 (covers 0.21% of sub-basin) + Navigable waterways: None + Land use: Plantation (0%), Agriculture-Rainfed-Single (5.8%), Flood Plain-Double (0.1%), Irrigated-Double (2.5%), Irrigated-Triple (0.1%)
Administration	States/Regions: Mandalay, Shan Major town/s: Mogoko, Monglon
Hydropower	Existing: 1 (Sedawgyi – 25 MW)

development	Planned: 1 (Sedawgyi upper – 64 MW) Under construction: 0 Identified potential site: 0

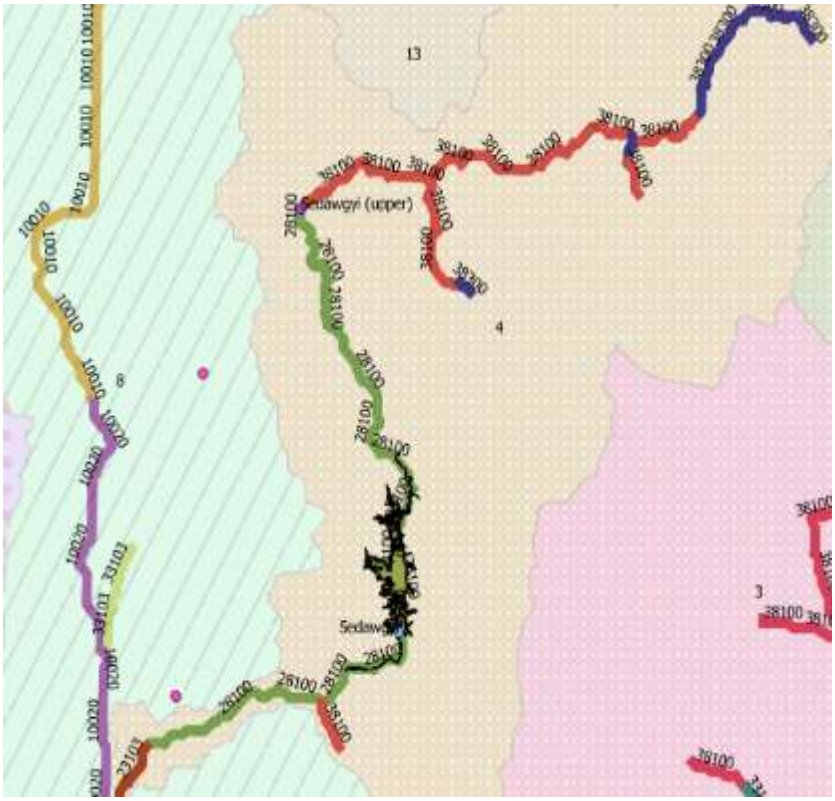
Geomorphology and sediment	Rating	2

Sub-basin size: small (28th percentile)

- Drains the western escarpment of the Shan plateau, including the southern area of the Moguk mining districts.
- The Sedawgyi hydropower and irrigation project is in the lower reaches, about 30 km upstream of the confluence with the Ayeyarwady.
- The project is effective at capturing sediment – satellite images show sediment-laden water entering the impoundment, with "clear" water being discharged.
- The impoundment has a long residence time (~30 days) and the dam has substantially altered the geomorphic functioning of the river system and its relationship with the Ayeyarwady.

Aquatic ecology and fisheries	Ecological value rating	2
	Human pressure rating	4

- This relatively small river basin and tributary on the left bank of the Ayeyarwady has a mean annual flow of 162 m^3/sec and a minimum flow estimated at 23 m^3/sec.
- It has five river reach types, of which two are rare (14%). However, 94% of the river flows through karst limestone.
- It has no KBAs and is not noted for endemic or threatened species.
- The upper reaches flow through forested hills. In the lower reaches, the Sedawgyi HPP (25 MW) is a combined irrigation and hydropower dam located about 40 km upstream from the confluence with the Ayeyarwady. Its reservoir extends for 16.5 km upstream and it provides a moderate degree of regulation of the flows.
- A second Sedawgyi dam upstream (65 MW) is proposed about 50 km upstream from the Sedwagyi reservoir.
- The lower reaches down to the confluence with the mainstem are more intensively cultivated. There is moderate pressure from mining activities and river health is expected to be poor.



Terrestrial biodiversity	Rating	2

Intact forest cover = 23%

KBA = 3%

- A habitat for the endangered Irrawaddy dolphin and a breeding ground for freshwater fish.

Social, livelihoods, and significant sites	Rating	2

- "Own account workers" (livelihood dependent on agriculture/NR) = 25% of the workforce
- Female-headed households = 28% of total households on average
- Avg. % of households owning a TV = 64%
- Ethnic minority groups = Palaung and Shan
- Sub-basin vulnerability rating = 2

Conflict	Rating	3

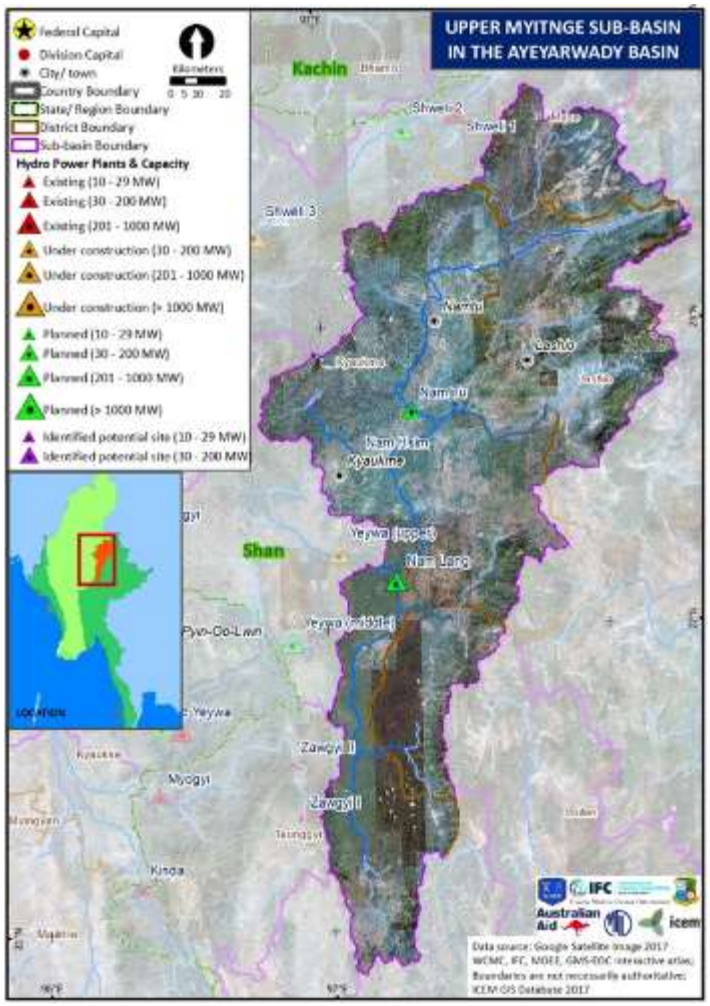
- Armed group presence = in about 50% of the sub-basin
- Est. battle deaths (1989-2015) = 0
- Media-reported armed conflict incidents (2012-2016) = 19
- Historical conflict-related displaced people (est.) = 0

4.1.9 Myitnge Upper

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
5	2	1	4	4

Overview



Sub-basin size = large

Location = Shan state, eastern Myanmar

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	49%
Slopes 3-10 soft rock	2%
Slopes<3 Elev>30m	3%
Slopes>10 hard rock	46%

Physical	Area: 22,447 km^2 Average rainfall: 1,628 mm Average sub-basin: outflow: 207.45 m^3/s
Socio-economic	Population: 718,996 Ethnic diversity: Kachins (Singpho), Karen, Palaung, Shan, and Wa (Kawa) Economic activities: + Mining area: 17.1 km^2 (covers 0.08% of sub-basin) + Navigable waterways: None + Land use: Plantation (0.4%), Agriculture-Rainfed-Single (16.3%), Irrigated-Single (0.1%), Irrigated-Double (0.6%)
Administration	States/Regions: Shan Major town/s: Kyaukme, Lashio, and Namtu

Hydropower development	Existing: 0 Under construction: 0 Planned: 3 (Nam Tu – 100 MW, Nam Lang – 210 MW, Nam Hsim – 30 MW) Identified potential site: 0

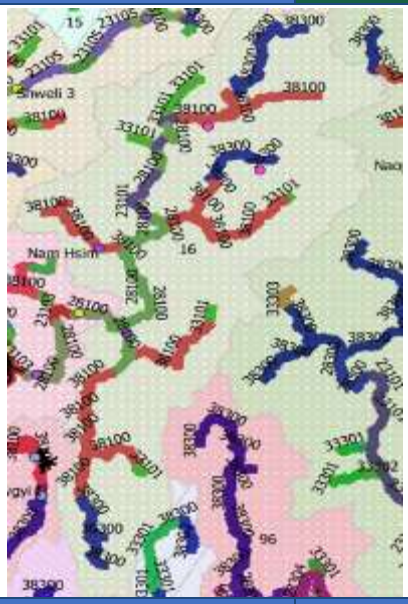
Geomorphology and sediment	Rating	5

Sub-basin size: very large (86th percentile; high Strahler Order, high rainfall)

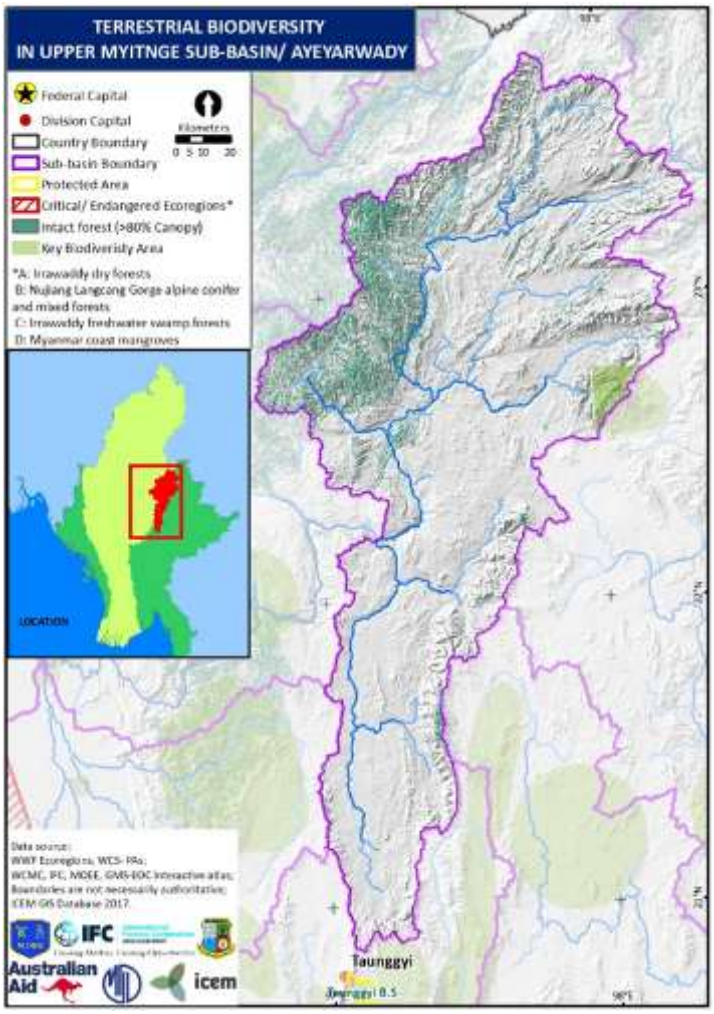
- Drains the steeply sloping Shan Plateau; no regulated rivers in the sub-basin and the high Strahler Order tributaries retain good connectivity.
- The river discharge enters the Lower Myitnge sub-basin in which the mainstem is regulated for big-scale HPPs with large impoundments. Although the Upper Myitnge's connectivity score was reduced due to this downstream regulation, its geomorphic rating remains a 5 due to the high values of other input indicators.
- This sub-basin is considered to have very high internal geomorphic functioning despite its greatly compromised connectivity with the Ayeyarwady. This is considered when evaluating potential planned HPPs.

Aquatic ecology and fisheries	Ecological value rating	2
	Human pressure rating	3

- Covers the headwaters of the Myitnge consisting of three branches – Nam Hsim and Nam Tu to the north and Nam Lang from the south.
- The combined flow of the three branches is 417 m^3/sec with an estimated minimum flow of 85 m^3/sec (Nam Tu = 205 m^3/sec, Nam Lang = 143 m^3/sec).
- Has five different river reach types, two of which are rare, making up 25% of the total reach length; 85% of the river reaches flow through karst limestone.
- No riverine KBAs and no endemic or threatened fish species.
- Has relatively low agricultural intensity and mining, but significant parts of the forest have been cleared for upland cultivation; the rural population density in these areas is quite high.



Terrestrial biodiversity	Rating	1



Intact forest cover = 8%

KBA = 1%; home to an endemic species of gecko and several cave-dwelling invertebrates

Social, livelihoods, and significant sites	Rating	4

- "Own account workers" (livelihood dependent on agriculture/NR) = 30% of the workforce
- Female-headed households = 26% of total households on average
- Avg. % of households owning a TV = 57%
- Ethnic minority groups = Kachins (Singpho), Karen, Palaung, Shan, and Wa (Kawa)
- Sub-basin vulnerability rating = 4

Conflict	Rating	5

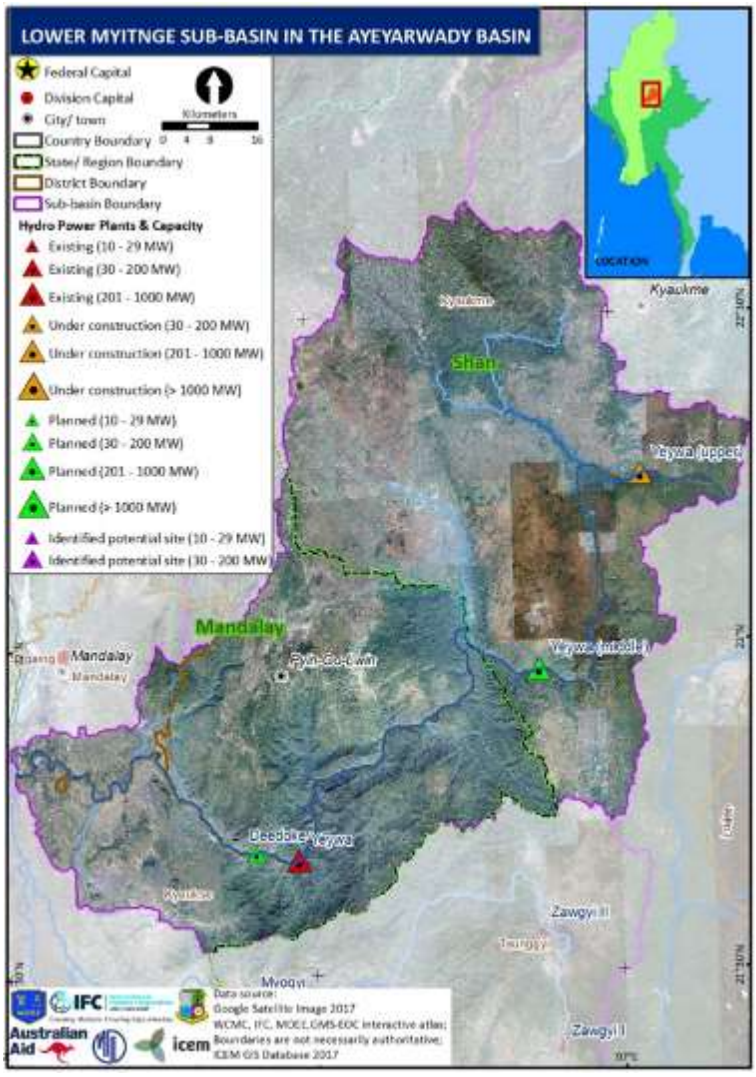
- Armed group presence: Multiple armed groups influential in much of the sub-basin, actively contesting territory with the Myanmar Army
- Est. battle deaths (1989-2015) = 63
- Media-reported armed conflict incidents (2012-2016) = 366
- Historical conflict-related displaced people (est.) = 4,374
- Conflict in this sub-basin has been extremely high (more than 10 incidents 2012-2016), thus vulnerability is likely underestimated.

4.1.10 Myitnge Lower

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
2	2	1	1	2

Overview



Sub-basin size = medium
Location: Spanning multiple states in the center of the country

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	54%
Slopes<3 Elev>30m	13%
Slopes>10 hard rock	32%

Physical	Area: 8,070 km^2 Average rainfall: 1,496 mm Average sub-basin outflow: 526.4 m3/s
Socio-economic	Population: 1,221,902 Ethnic diversity: Palaung, Shan Economic activities: + Mining area: 10.4 km^2 (covers 0.13% of sub-basin) + Navigable waterways: None + Land use: Plantation (0%), Agriculture-Rain-fed-Single (23%), Irrigated-Single (0.1%), Irrigated-Double (4.9%), Irrigated-Triple (0.6%)

Administration	States/Regions: Mandalay and Shan Major town: Pyin-Oo-Lwin
Hydropower development	Existing: 1 (Yeywa – 790 MW) Under construction: 1 (Yeywa upper – 280 MW) Planned: 2 (Deedoke – 66 MW, Yeywa middle – 700 MW) Identified potential site: 0

Geomorphology and sediment	Rating	2

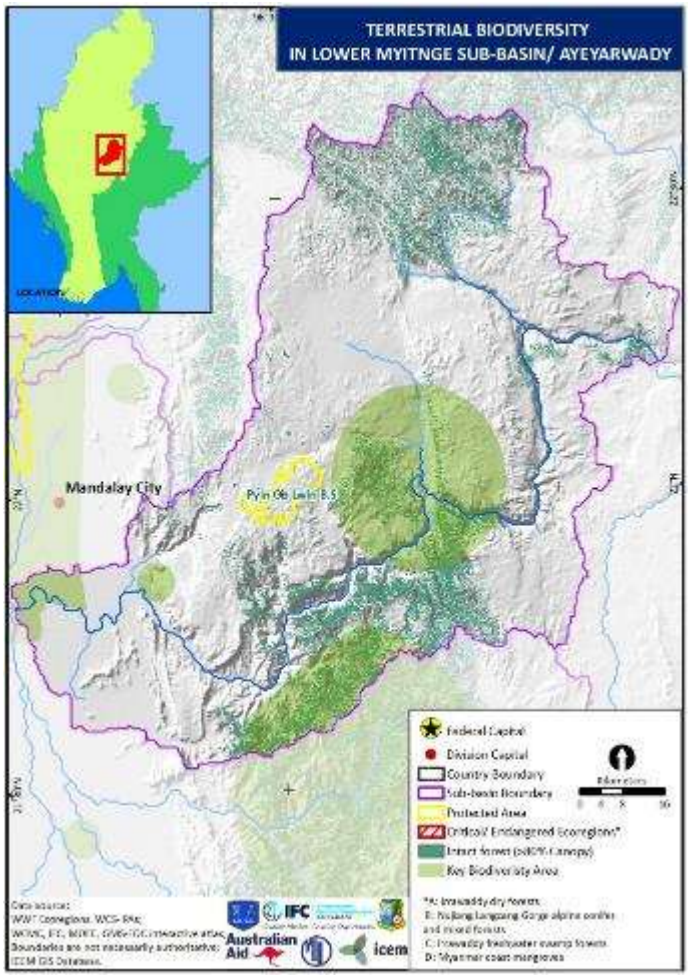
Sub-basin size: moderate (44th percentile; Strahler Order 4)

- A very large and complex river system – the Lower Myitnge drains a steeply sloping predominantly "hard rock" area and likely generates large volumes of sand and gravel.
- The connectivity, sediment delivery, and flow pattern of the Lower Myitnge has been disrupted through the Yeywa (operating) and Upper Yeywa (under construction) HPPs.
- These projects include large storages effective at trapping sediment and allow large-scale alterations of the flow regime.

Aquatic ecology and fisheries	Ecological value rating	2
	Human pressure rating	4

- Joins the Ayeyarwady mainstem just downstream of Mandalay; shortly before this confluence, the sub-basin is joined by the Zawgyi and Panlaung Chaung rivers. At the confluence with the mainstem, the flow is 724 m^3/sec and estimated minimum flow is 149 m^3/sec, of which 73% comes from the Myitnge river.
- The sub-basin has seven river reach types; two of them are rare but cover only 5% of the river reach lengths. However, 62% of the river reaches flow through karst – mostly as large rivers at low elevation.
- Human pressures from agriculture and mining are moderate. Had one riverine KBA – Mehon or Doke-hta Waddy river; it was important for turtles but has since been inundated by the Yeywa HPP.
- The Yeywa HPP (790 MW) is located about 100 km upstream from the confluence with the mainstem and the reservoir extends for 75 km upstream. It has had a significant impact on the aquatic ecology, water quality, water flows, and degree of regulation, as a result of the loss of connectivity between the mainstem and the rare river reaches in the Upper Myitnge.
- The Upper Yeywa HPP (290 MW) is under construction and is expected to have a more moderate impact on the river ecology, especially as connectivity with the mainstem was already lost with the first dam. A third dam is planned between the two Middle Yeywa so that the lengths of impounded reservoir will extend for 200 km above the Yeywa HPP. A run-of-river re-regulating dam at Deedoke, 20 km downstream of Yeywa is also planned.

Terrestrial biodiversity	Rating	1



Intact forest cover = 11%

KBA = 17%

- A habitat for the Irrawaddy dolphin, several species of freshwater fish, and several species of threatened water birds; the Pyin Oo Lwin bird sanctuary makes up about 1% of the sub-basin.

Protected area = 0%
Critically endangered ecoregions = 0%

Social, livelihoods, and significant sites	Rating	1

- "Own account workers" (livelihood dependent on agriculture/NR) = 23% of the workforce
- Female-headed households = 26% of total households on average
- Avg. % of households owning a TV = 60%
- Ethnic minority groups = Palaung and Shan
- Sub-basin vulnerability rating = 1

Conflict	Rating	2

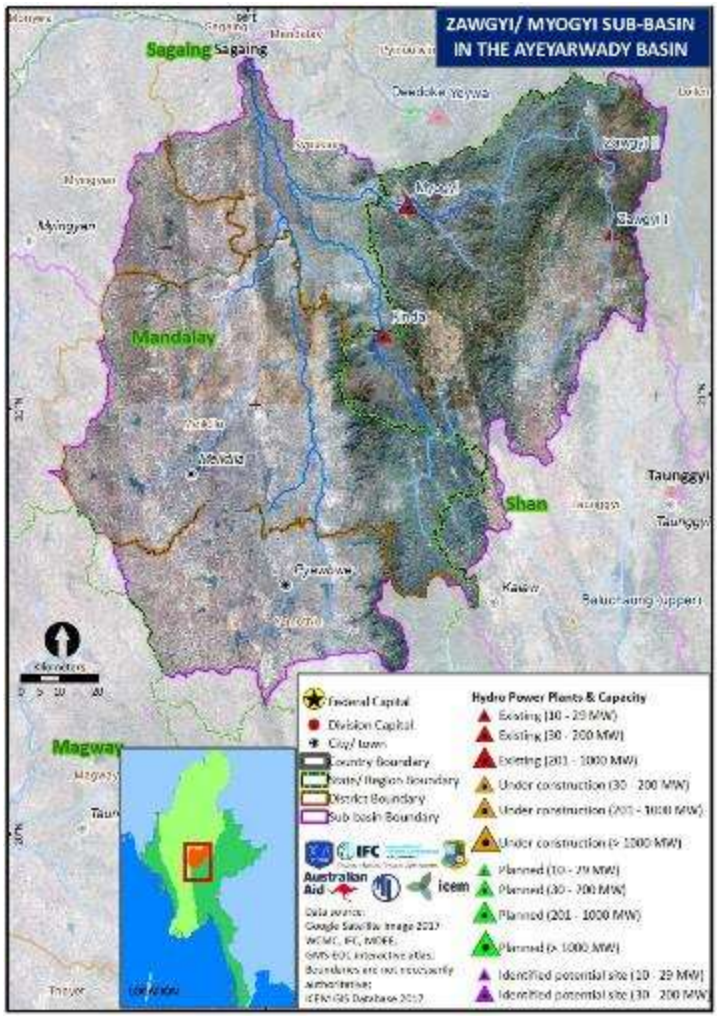
- Armed group presence = small, borders Danu Self-administered Zone (Danu SAZ)
- Est. battle deaths (1989-2015) = 17
- Media-reported armed conflict incidents (2012-2016) = 10
- Historical conflict-related displaced people (est.) = 0

4.1.11 Zawgyi/Myogyi

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
3	2	1	4	2

Overview



Sub-basin size = medium

Location = Shan state, central Myanmar

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	30%
Slopes 3-10 soft rock	1%
Slopes<3 Elev>30m	48%
Slopes>10 hard rock	21%

Physical	Area: 16,327 km^2 Average rainfall: 1,185 mm Average sub-basin outflow: 195.2 m^3/s
Socio-economic	Population: 2,099,186 Ethnic diversity: Karen and Shan Economic activities: + Mining area: 88.2 km^2 (covers 0.54% of sub-basin) + Navigable waterways: None + Land use: Plantation (0%), Agriculture-Rainfed-Single (44.2%), Rainfed-Double (0.1%), Irrigated-Double (5%), Irrigated-Triple (0.5%)
Administration	States/Regions: Magway, Mandalay, and Sagaing Major town/s: Meiktila and Pyawbwe

Hydropower development	Existing: 4 (Kinda – 56 MW, Myogyi – 30 MW, Zawgyi I – 18 MW, Zawgyi II – 12 MW) Under construction: 0 Planned: 0 Identified potential site: 0

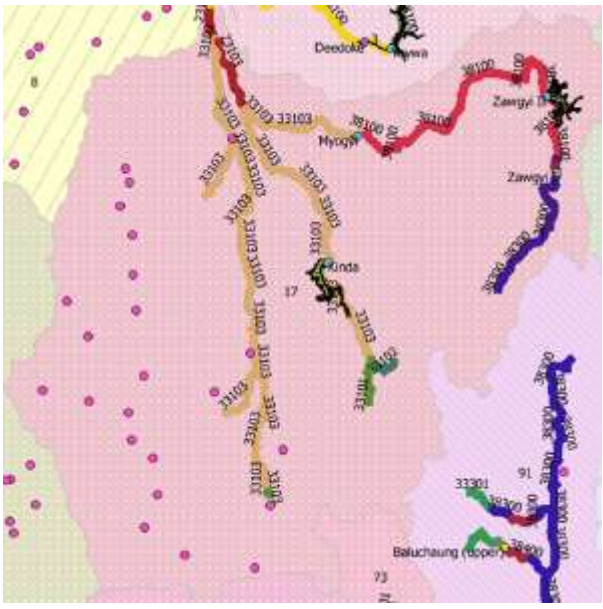
Geomorphology and sediment	Rating	3

Sub-basin size = large (72nd percentile)

- Third sub-basin in the Myitnge occupying the western portion of the large catchment.
- The headwaters of one major tributary extend into the steeply sloping flanks of the Shan plateau, while the other main tributary is confined to low-lying central basin.
- The steeper headwater area has been developed for hydropower with four HPPs established.
- The regulated flow and low-lying areas with lower rainfall and sediment input result in the geomorphic rating of 3.

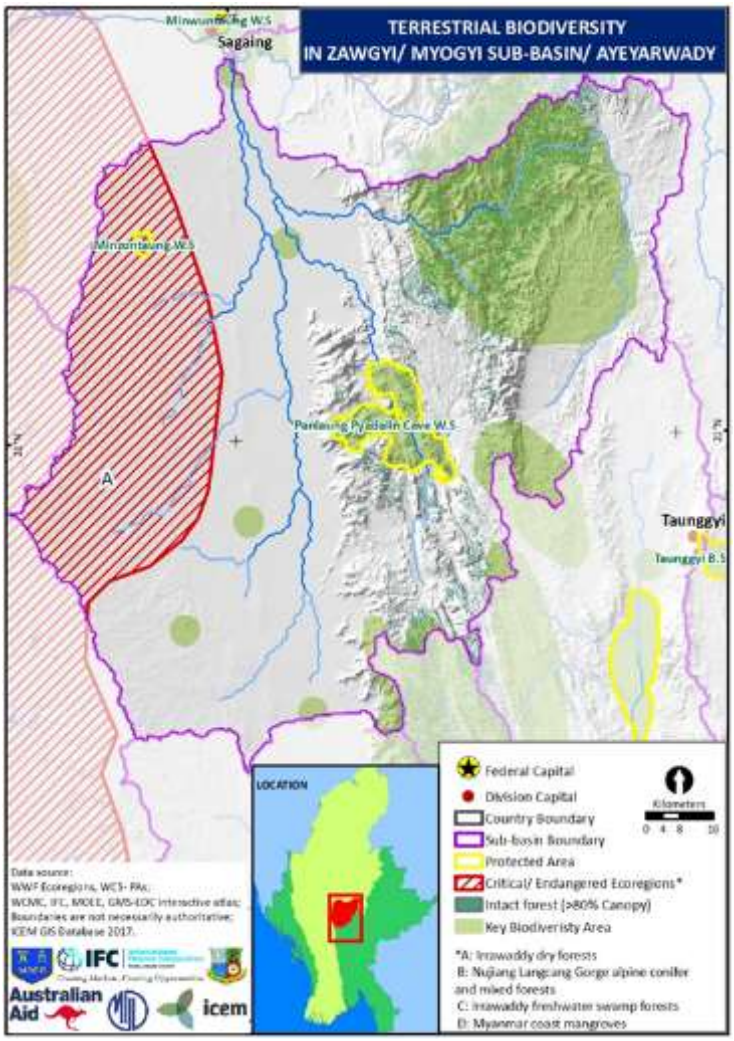
Aquatic ecology and fisheries	Ecological value rating	2
	Human pressure rating	5

- The Zawgyi and Panlaung Chaung rivers join the Myitnge just before the confluence with the Ayeyarwady mainstem.
- The mean annual flows of the two rivers are 195 m^3/sec with a minimum flow estimated at 39 m^3/sec.
- They have seven different river reach types of which three are rare, making up 10% of the total reach length. The river reach type of the Panlaung Chaung is medium river, in moist broadleaf forest region at low elevation, with floodplains. The Zawgyi River is more diverse and its reach types include medium rivers in karst at low elevation and at high elevation in the upper reaches.



- The Panlaung Pyadalin Cave Wildlife Sanctuary, located in one of the branches of the Panlaung Chaung near the Kinda dam, is a limestone cave with Neolithic cave paintings. The lower Doke-hta Wady watershed forest has also been identified as a KBA on the Zawgyi river.
- Has more than 20 irrigation reservoirs (pink dots) in the western part of the sub-basin, with medium agricultural intensity and high mining activities.
- The sub-basin has four existing combined hydropower and irrigation reservoirs: Kinda (56 MW, 14.5 km length reservoir, >9 months of storage capacity); Myogi (30 MW, 10 km reservoir, high degree of regulation); Zawgyi II (12 MW, 8 km reservoir, 5 months storage, and high degree of regulation); and Zawgyi I (18 MW), a diversion dam with 2 km de-watered zone and no storage.

Terrestrial biodiversity	Rating	1



Intact forest cover = 4%

KBA = 20%, a habitat for threatened water birds and several species of cave invertebrates

Protected areas = 2%, the Minzontaung and Panlaung Pyadalin Cave wildlife sanctuaries

Critically endangered ecoregions = 19%, the Irrawaddy dry forest that has been affected by infrastructure development and forest degradation

Social, livelihoods, and significant sites	Rating	4

- "Own account workers" (livelihood dependent on agriculture/NR) = 25% of the workforce
- Female-headed households = 24% of total households on average
- Avg. % of households owning a TV = 43%
- Ethnic minority groups = Karen and Shan
- Sub-basin vulnerability rating = 4

Conflict	Rating	2

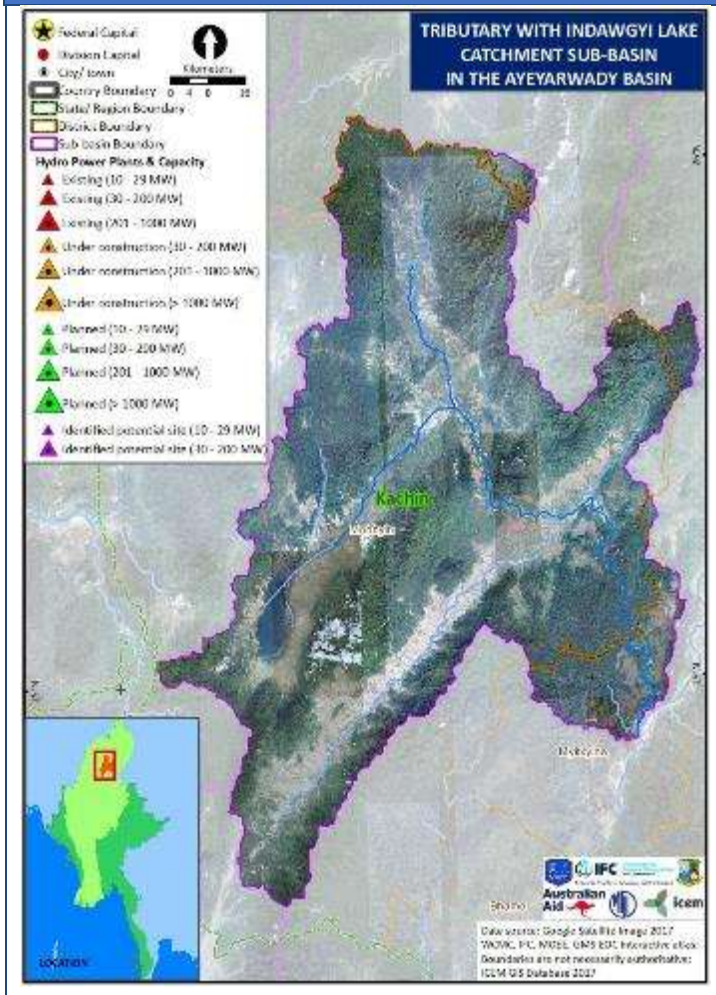
- Armed group presence: Danu SAZ covers <50% of the sub-basin
- Est. battle deaths (1989-2015) = 5
- Media-reported armed conflict incidents (2012-2016) = 0
- Historical conflict-related displaced people (est.) = 3,187

4.1.12 Tributary with Indawgyi Lake Catchment

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
3	4	3	1	4

Overview



Sub-basin size = medium
Location = Tributary with the Indawgwi Lake catchment, Kachin State, western Myanmar

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	85%
Slopes<3 Elev>30m	8%
Slopes>10 intermed rock	7%

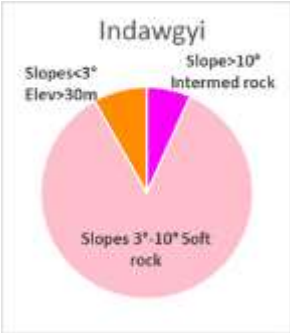
Physical	Area: 9,357 km^2 Average rainfall: 2,280 mm Average sub-basin outflow: 814.5 m^3/s
Socio-economic	Population: 673,608 Ethnic diversity: Kachins (Singpho) and Shan Economic activities: + Mining area: 11 km^2 (covers 0.12% of sub-basin) + Navigable waterways: None + Land use: Plantation (0%), Agriculture-Rainfed-Single (8.2%), Irrigated-Single (0.1%), Irrigated-Double (3.5%)
Administration	States/Regions: Kachin and Sagaing Major town/s: Mogaung, Kamaing, Mohnyin, and Hopin

Hydropower development	Existing: 0 Under construction: 0 Planned: 0 Identified potential site: 0

Geomorphology and sediment	Rating	3

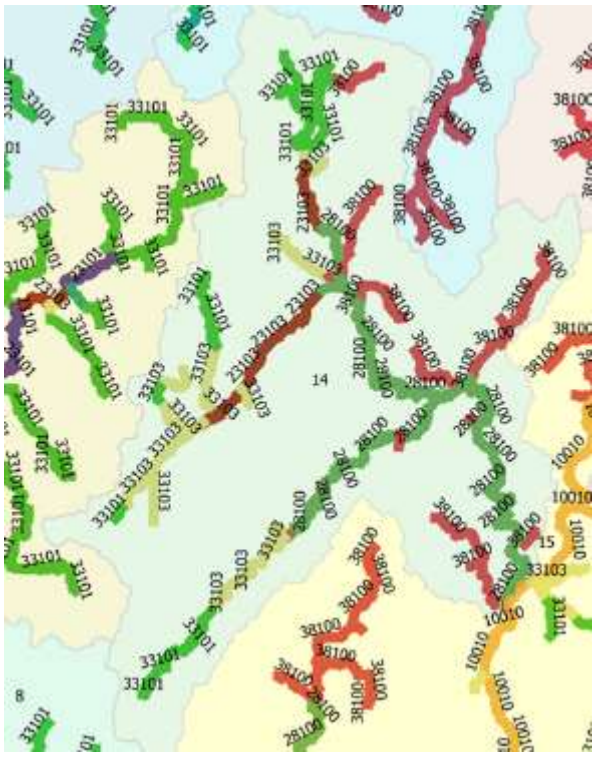
Sub-basin size: medium (53rd percentile)

- The Indawgyi Lake is in a tectonically active fault-controlled sub-basin within the northern Ayeyarwady basin; the lake connects to the mainstem Ayeyarwady via an outlet in the north and a highly meandering river.
- The lake experiences high levels of sedimentation from Land use, including mining activities.
- This sub-basin hosts important ecological habitats. Although its geomorphic relevance on a basin scale is considered moderate, it has high value in a local context.

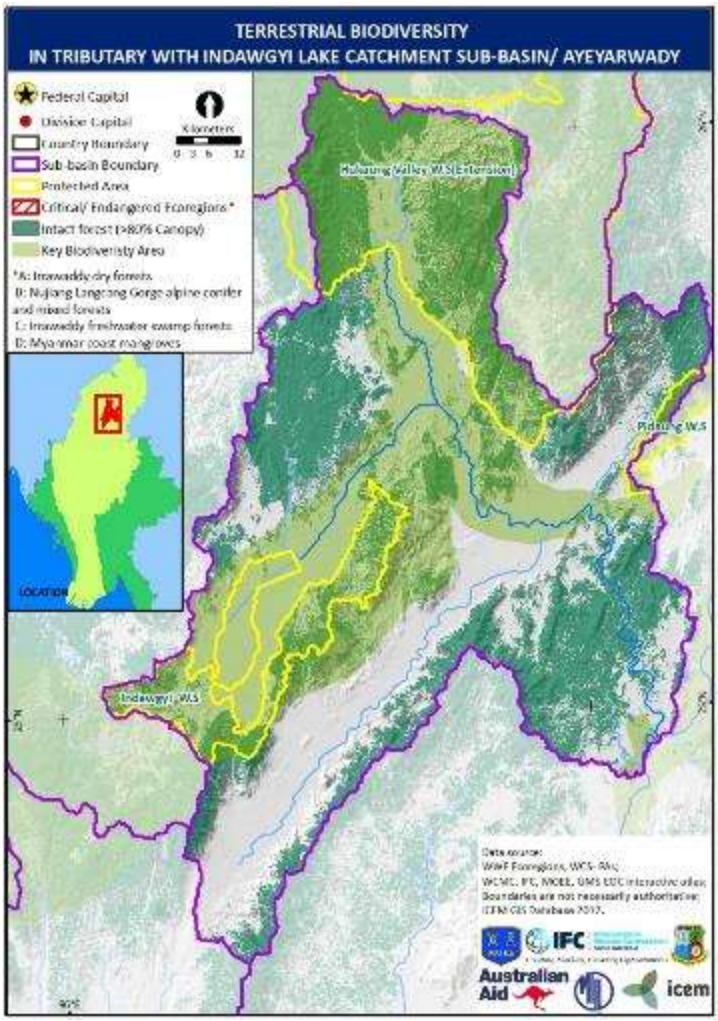


Aquatic ecology and fisheries	Ecological value rating	4
	Human pressure rating	2

- This tributary with the Indawgyi Lake catchment is large and complex, with its confluence on right bank of the Ayeyarwady about 155 km downstream from the Myitsone. The mean annual flow is estimated at 814 m^3/sec with a minimum flow of about 100 m^3/sec.
- It has five different river reaches, none of which are rare, but with over 50% flowing through karst limestone.
- The basin consists of three main valleys separated by hill ridges, one flowing from the north and two from the south. In the southwest valley lies the Indawgyi Lake, with wet grasslands surrounding it.
- The lake is a Ramsar site and globally important wetland area. It is also a wildlife sanctuary recognized for its waterbird populations and fish diversity. It is an area of high endemism for fish and other aquatic organisms.
- Human pressures are increasing, with the valleys extensively cultivated; only the hillsides remain forested. About 30,000 people live around the lake, and much of the surrounding grasslands have been converted to cultivating wet rice.
- Gold mining activity in the Indawgyi Lake catchment is beginning to cause serious contamination in the lake.



Terrestrial biodiversity	Rating	3



Intact forest cover = 41%

KBA = 49%

- An important habitat for several endangered species of fish and freshwater turtles

Protected areas = 26%

- Three wildlife sanctuaries: Pidaung, Indawgyi, and Hukaung Valley

Social, livelihoods, and significant sites	Rating	1

- "Own account workers" (livelihood dependent on agriculture/NR) = 25% of the workforce
- Female-headed households = 25% of total households on average
- Avg. % of households owning a TV = 66%
- Ethnic minority groups = Kachins (Singpho) and Shan
- Sub-basin vulnerability rating = 1

Conflict	Rating	4

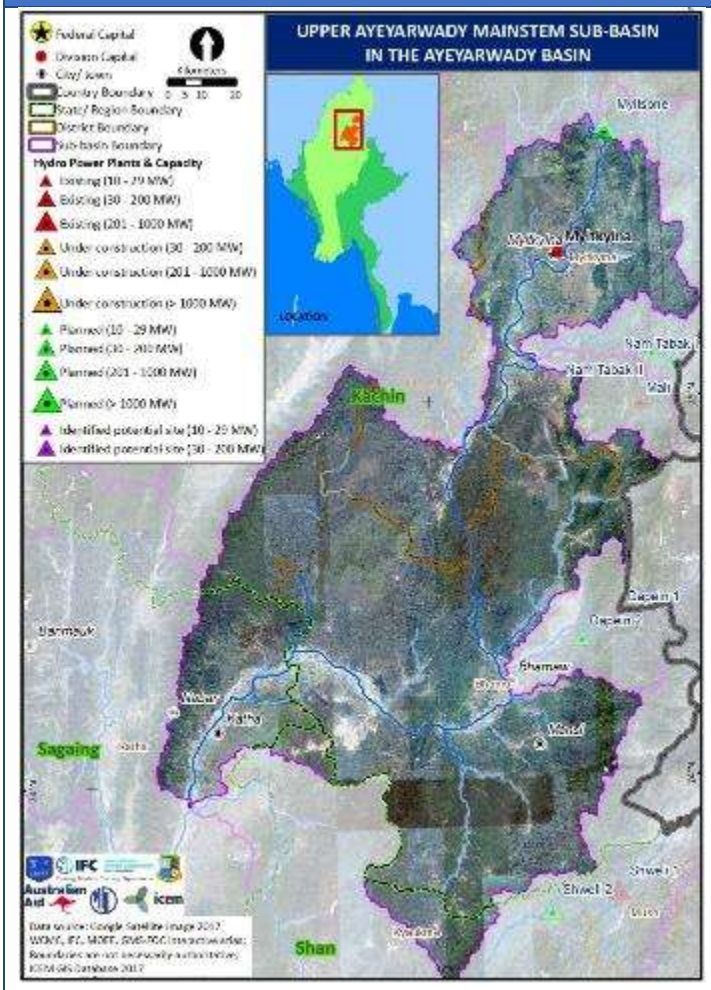
- Armed group presence: Multiple armed groups influential in much of the sub-basin, actively contesting territory with the Myanmar Army
- Est. battle deaths (1989-2015) = 30
- Media-reported armed conflict incidents (2012-2016) = 41
- Historical conflict-related displaced people (est.) = 2,771

4.1.13 Ayeyarwady Upper

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
3	2	2	4	5

Overview



Sub-basin size = large
Location = Kachin and Shan states, northeastern Myanmar, bordering China

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	6%
Slopes 3-10 soft rock	61%
Slopes<3 Elev>30m	26%
Slopes>10 hard rock	7%

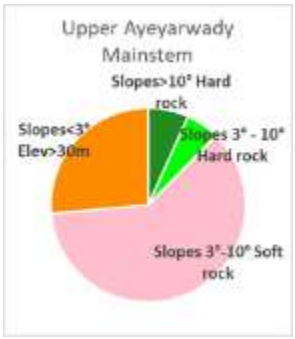
Physical	Area: 17,939 km^2 Average rainfall: 1,716 mm Average sub-basin outflow: 6,245.1 m^3/s
Socio-economic	Population: 894,488 Ethnic diversity: Kachins (Singpho) and Shan Economic activities: + Mining area: 9.3 km^2 (covers 0.05% of sub-basin) + Navigable waterways: 301.2 km + Land use: Plantation (0.2%), Agriculture-Rainfed-Single (8.9%), Flood Plain-Single (0.2%), Flood Plain-Double (0.6%), Irrigated-Single (0.2%), Irrigated-Double (3.4%), Irrigated-Triple (0.1%)
Administration	States/Regions: Kachin, Sagaing, and Shan Major town/s: Katha, Mansi, and Myitkyina

Hydropower development	Existing: 0 Under construction: 0 Planned: 0 Identified potential site: 0

Geomorphology and sediment	Rating	3

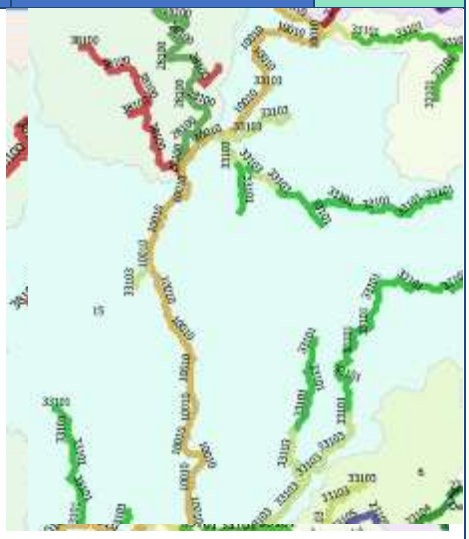
Sub-basin size: large (79th percentile; Strahler Order 1 & 2)

- A large catchment comprising numerous small Strahler Order 1 and 2 watersheds that report directly to the mainstem.
- Contains large, flat-lying areas associated with the floodplains around Bhamo and cuts through hills to enter the Sagaing fault zone at the southern extents.
- Inflows to the sub-basin include the large unregulated flow from the Mali Hka and Nmae Hka, and the regulated flows of the Mali Creek, Dapein and Shweli rivers.
- The moderate geomorphology rating is linked to the low Strahler Order and low sediment contribution from the basin.
- NOTE: This rating does not apply to the mainstem Ayeyarwady, which is considered a special unit with a geomorphic value of 5.



Aquatic ecology and fisheries	Ecological value rating	2
	Human pressure rating	2

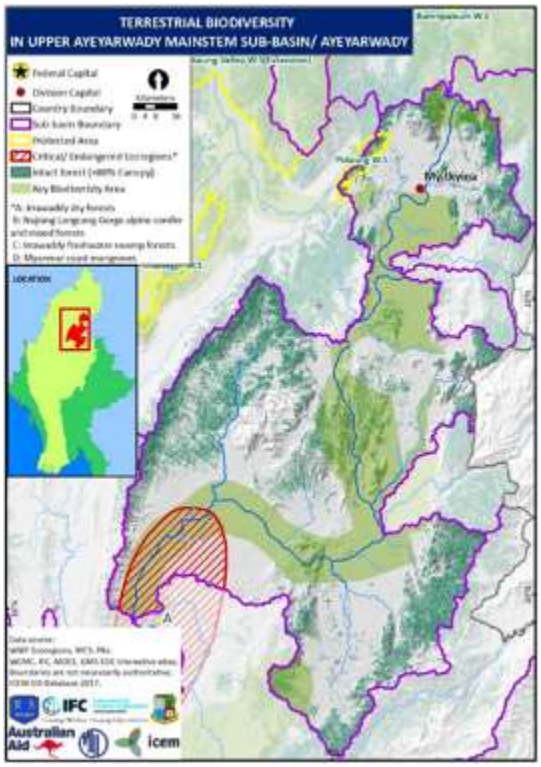
- The Ayeyarwady Upper starts at the confluence with the Mali Hka and N'Mae Hka extending to the confluence with the Shweli River.
- The mainstem consists of rock-cut river channel and anastomose channel, neither of which are rare, but it is a critical migratory route for fish to the Ayeyarwady headwaters
- The tributaries flowing into the mainstem have a low ecological value because they are quite small and not very diverse. There are 11 river reach types of which six are rare, making up about 29% of all the river reaches in the sub-basin; 37% of the river reaches run through karst limestone, especially the tributaries on the right bank.
- The mainstem flows through several recognized riverine and wetland KBAs, including the Ayeyarwady sections, Myintkyina to Sinbo, Bhamo and Shwegyu sections, 96 Inns, and Nam Sam Chaung.



- Human pressure rating is low, with some mining and little agriculture activity, low population density, and few roads. The river health status is expected to be good.

- Note: The Ecological Value rating is for the tributaries only, not for mainstem reaches

Terrestrial biodiversity	Rating	2



Intact forest cover = 21%

KBA = 31%; a habitat for aquatic flora and fauna including the endangered Irrawaddy dolphin and several endemic species of fish.

Protected area = 0.5%; the Pidaung Wildlife Sanctuary

Critically endangered ecoregion = >5%; the Irrawaddy dry forest before human influence was introduced to the ecoregion

Social, livelihoods, and significant sites	Rating	4

- "Own account workers" (livelihood dependent on agriculture/NR) = 29% of the workforce
- Female-headed households = 30% of total households on average
- Avg. % of households owning a TV = 60%
- Ethnic minority groups = Kachins (Singpho) and Shan
- Sub-basin vulnerability rating = 4

Conflict	Rating	5

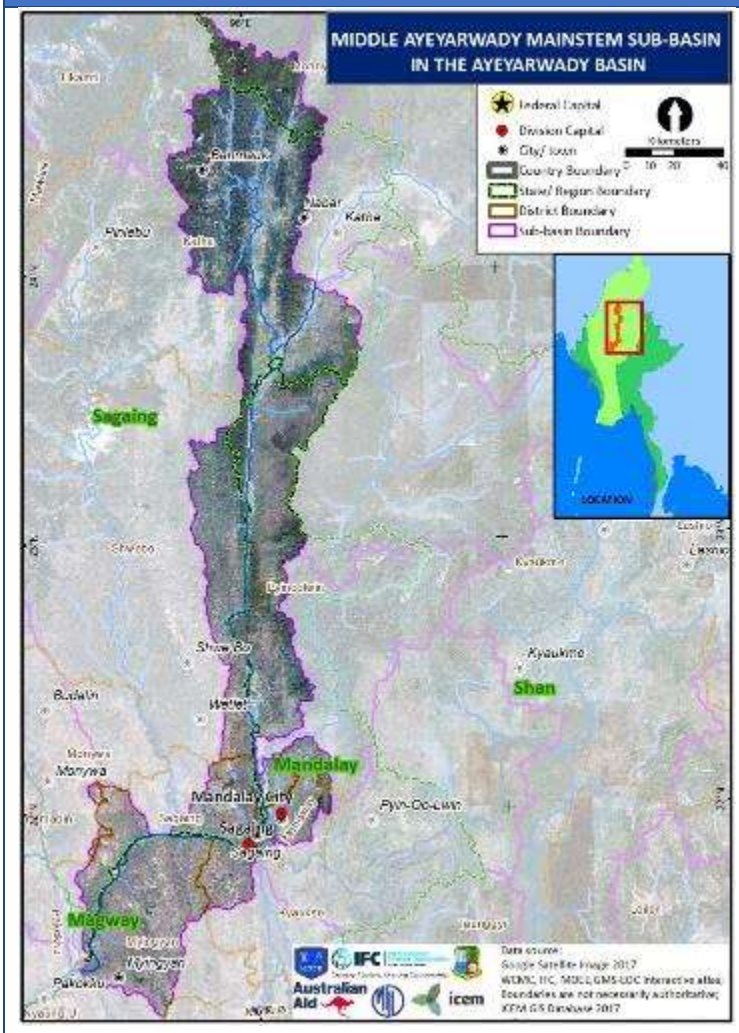
- Armed group presence: High influence in much of the sub-basin, including areas under KIO control
- Est. battle deaths (1989-2015) = 64
- Media-reported armed conflict incidents (2012-2016) = 110
- Historical conflict-related displaced people (est.) = 48,027

4.1.14 Ayeyarwady Middle

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
2	1	2	2	1

Overview



Sub-basin size = large
Location = spanning several states in the center of Myanmar

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	45%
Slopes<3 Elev>30m	55%

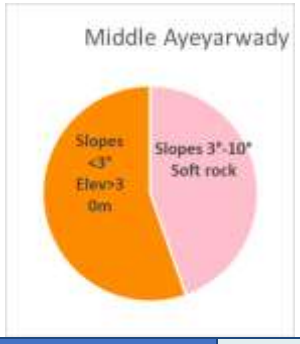
Physical	Area: 17,940 km^2 Average rainfall: 1,163 mm Average sub-basin outflow: 9,378.6 m^3/s
Socio-economic	Population: 3,344,726 Ethnic diversity: Kachins (Singpho), Lisu, and Shan Economic activities: + Mining area: 35.1 km^2 (covers 0.2% of sub-basin) + Navigable waterways: 374 km + Land use: Plantation (0%), Agriculture-Rainfed-Single (32.3%), Flood Plain-Single (0.8%), Flood Plain-Double (0.3%), Irrigated-Single (0.3%), Irrigated- Double (4.2%), Irrigated-Triple (0.5%)
Administration	States/Regions: Kachin, Magway, Mandalay, Sagaing, and Shan Major town/s: Banmauk, Mandalay, Myingyan, Nabar, and Sagaing

Hydropower development	Existing: 0 Under construction: 0 Planned: 0 Identified potential site: 0

Geomorphology and sediment	Rating	2

Sub-basin size: large (81st percentile; maximum Strahler Order 2)

- The low-order tributaries are attributable to the narrow nature of the sub-basin, which is largely fault controlled, as the Ayeyarwady occupies the Sagaing fault zone through this area.
- Once out of the fault zone, the Ayeyarwady "spills" into a broad alluvial plain, accounting for the large percentage of flat-lying area in the basin.
- The rating of "2" is attributable to the low Strahler Order inputs, combined with low potential sediment input.
- NOTE: This rating pertains only to the tributaries draining into the Ayeyarwady and does not apply to the mainstem, which is considered a special unit with a geomorphic value of 5.



Aquatic ecology and fisheries	Ecological value rating	1
	Human pressure rating	3

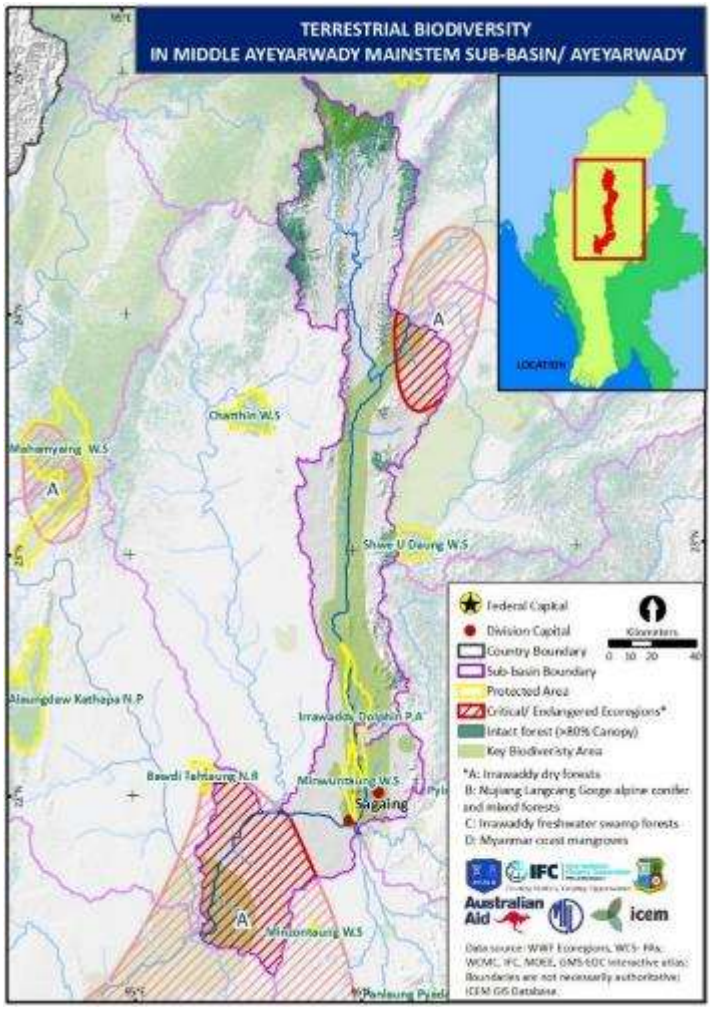
- The Ayeyarwady Middle is a long stretch of 386 km from the Upper Ayeyarwady mainstem down to the confluence with the Chindwin.
- The mainstem initially flows for 64 km through an anastomosing channel (code 10020) consisting of several channels enclosing floodplains, with oxbow lakes and islands. It then flows through a very straight rock-cut gorge (code 10010) between Takaung and Kyaukmyaung before passing through another anastomosing channel that follows a broad, open course through the central dry zone where large areas consist of alluvial flats. From Mandalay, the river makes an abrupt westward turn before curving southwest to unite with the Chindwin River.

- The mainstem is joined on the left bank above Mandalay by the Ma Gyi Chaung River (with the Sedwagyi HPP) and below Mandalay by the Myitnge River (with the Yeywa HPP). On the right bank, the Mu River joins about 100 km upstream from the Chindwin confluence.
- The other tributaries flowing into the Ayeyarwady Middle mainstem are very small and mainly in the northern section (right hand diagram). There are only three river reach types all of which are common. By themselves, they have a Very Low Ecological Value.
- The mean annual flow at the top end of this sub-basin is 6,254 m^3/sec and before the Chindwin confluence is 9,379 m^3/sec.
- The mainstem is a critical migratory pathway for fish and key for the overall connectivity of the river. The entire stretch upstream of Mandalay is important for the Irrawaddy dolphin and turtles with recognized riverine KBAs in the Shwegyu and Singu sections and the Irrawaddy dolphin protected area.
- Human pressures from agriculture are generally moderate above Mandalay, but these increase below

Mandalay where there are at least 10 irrigation reservoirs in the sub-basin. Mining pressures are also moderate.

- Lower parts of the Ayeyarwady Middle mainstem are increasingly polluted especially through runoff, sewage, and industrial waste waters from major urban areas such as Mandalay and Sagaing. Navigation intensity also increases below Mandalay.
- Note: The Ecological Value rating is for the tributaries only, not for mainstem reaches

Terrestrial biodiversity	Rating	2



Intact forest cover = 9%

KBA = 29% incl. dry zone wetlands that are habitat for the endangered Irrawaddy dolphin and threatened water birds

Critically endangered ecoregion = 22%; Irrawaddy dry forest

The Minwuntaung and Shwe U Daung Wildlife Sanctuaries, though small (<1%), are also in this sub-basin.

Social, livelihoods, and significant sites	Rating	2

- "Own account workers" (livelihood dependent on agriculture/NR) = 23% of the workforce
- Female-headed households = 26% of total households on average
- Avg. % of households owning a TV = 59%
- Ethnic minority groups = Kachins (Singpho), Lisu, and Shan
- Sub-basin vulnerability rating = 2

Conflict	Rating	1

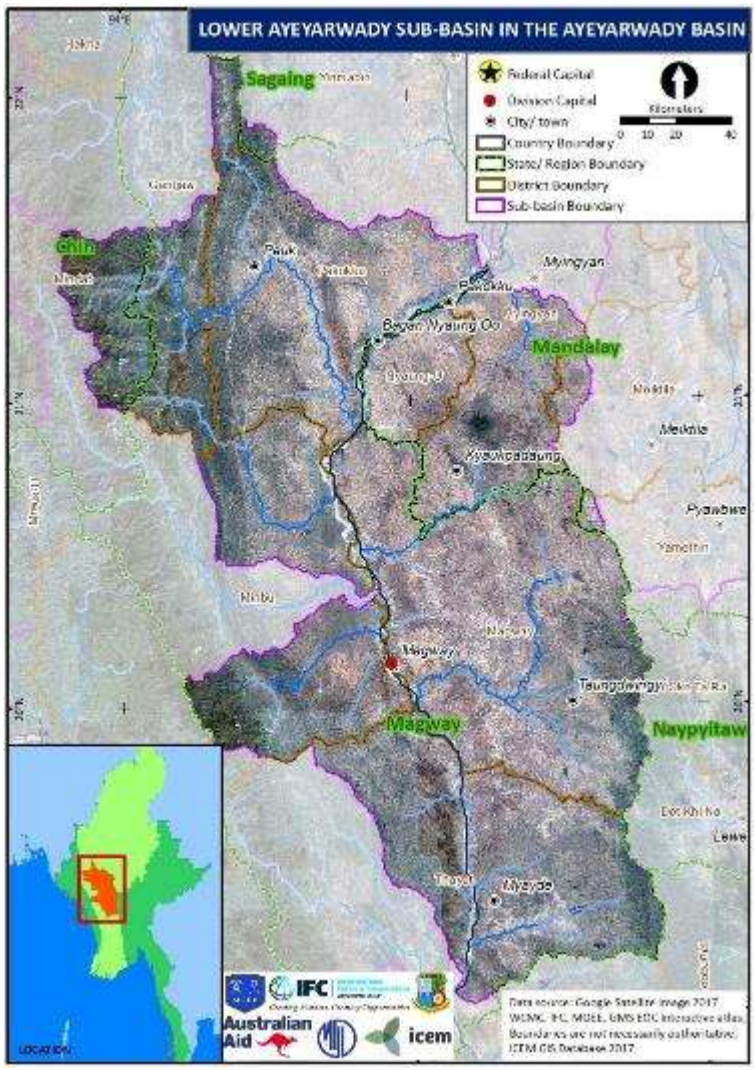
- Armed group presence: None or low
- Est. battle deaths (1989-2015) = 5
- Media-reported armed conflict incidents (2012-2016) = 1
- Historical conflict-related displaced people (est.) = 23

4.1.15 Ayeyarwady Lower

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
4	2	2	4	1

Overview



Sub-basin size = second-largest spanning multiple states
Location = in eastern and central Myanmar

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	28%
Slopes<3 Elev>30m	67%
Slopes>10 intermed rock	5%

Physical	Area: 37,114 km^2 Average rainfall: 875 mm Average sub-basin outflow: 15,418.2 m3/s

Socio-economic	Population: 3,563,016 Ethnic diversity: Chini, Karen Economic activities: + Mining area: 17.6 km^2 (covers 0.05% of sub-basin) + Navigable waterways: 319 km + Land use: Plantation (0%), Agriculture-Rainfed-Single (43.6%), Flood Plain-Single (0.2%), Flood Plain-Double (0.2%), Irrigated-Single (0.2%), Irrigated-Double (1.2%), Irrigated-Triple (0.4%)
Administration	States/Regions: Bago, Chin, Magway, Mandalay, Nay Pyi Taw, Rakhine, and Sagaing Major town/s: Bagan Nyaung Oo, Kyaukpadaung, Magway, Myayde, Pakokku, Pauk, and Taungdwingyi
Hydropower development	Existing: 0 Under Construction: 0 Planned: 0 Identified potential site: 0

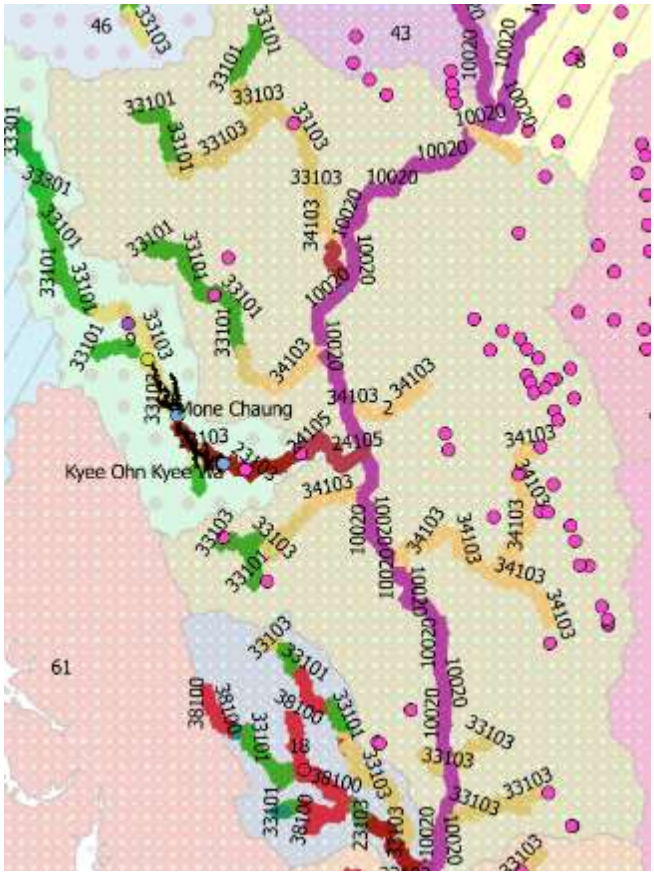
Geomorphology and sediment	Rating	4

Sub-basin size: very large (98th percentile; Strahler Order 3 rivers)

- Encompasses low-lying areas of the Central Dry Belt, with some tributaries extending into the Arakan range.
- These hills likely contribute pulses of sediment during intense rainfall events.
- Contains the most downstream bedrock sections that exert control on the course of the mainstem Ayeyarwady before the river enters the alluvial delta.
- NOTE: This score pertains only to the tributaries draining into the Ayeyarwady and does not apply to the mainstem, which is considered a special unit with a geomorphic value of 5.

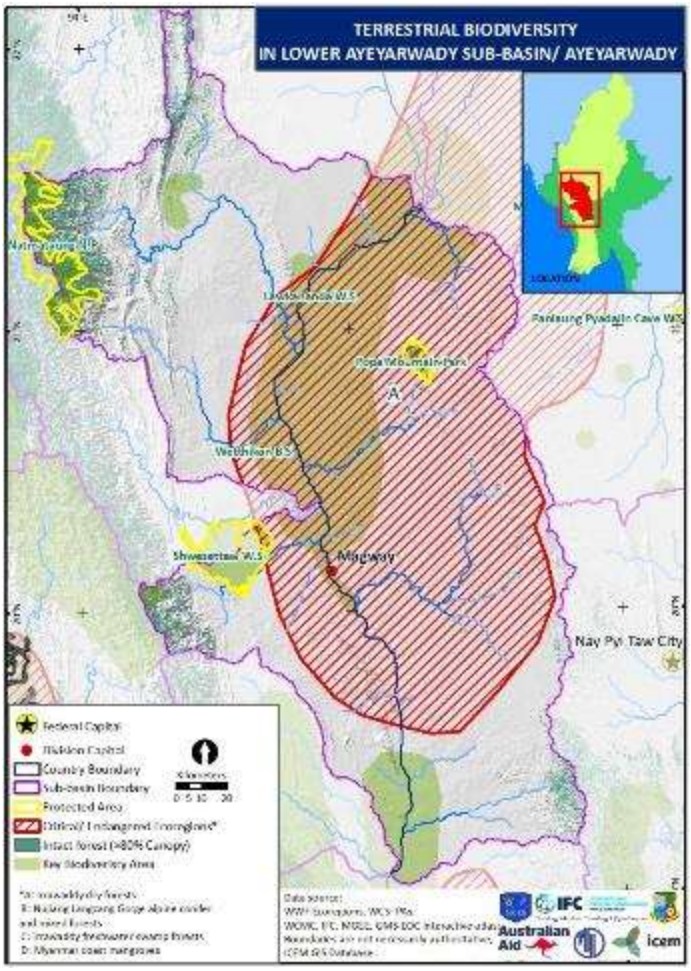
Aquatic ecology and fisheries	Ecological value rating	2
	Human pressure rating	3

- Contains the mainstem from the confluence with the Chindwin to that with the Man Chaung. The mainstem reaches are 338 km of anastomose channel – multiple channels enclosing floodplains and islands. Several tributaries enter on the right bank (of which the Mone Chaung and Man Chaung are described separately) and one enters on the left bank.
- There are seven river reaches of which three are rare, making up 28.5% of the reach lengths. There are no karst reaches. The predominant reach types in the tributaries are medium river, in moist broadleaf forest region at low elevation, with low gradient and with floodplains. The main rare reach type is medium river, in dry broadleaf forest region, with floodplains.
- The Ayeyarwady mainstem is an important route for migratory fish species, especially for the Hilsa. There are spawning areas for the Hilsa and several other species near Magway and Pakokku.



- Human pressures on the river include pollution from urban wastes and increasing agricultural intensity affecting water quality as the mainstem is an important navigation route. There are over 40 irrigation reservoirs constructed in this sub-basin, especially to the east of the mainstem.
- Note: The Ecological Value rating is for the tributaries only, not for mainstem reaches

Terrestrial biodiversity	Rating	2



Intact forest cover = 3%

KBA = 23%

Protected area = 0%

Critically endangered ecoregion = 51% of the sub-basin used to comprise the Irrawaddy dry forest ecoregion, for which it will receive a red star, signifying the need to protect the remaining dry forest

Social, livelihoods, and significant sites	Rating	4

- "Own account workers" (livelihood dependent on agriculture/NR) = 23% of the workforce
- Female-headed households = 25% of total households on average
- Avg. % of households owning a TV = 36%
- Ethnic minority groups = Chini and Karen

Conflict	Rating	1

- Armed group presence = none to low
- Est. battle deaths (1989-2015) = 4
- Media-reported armed conflict incidents (2012-2016) = 0
- Historical conflict-related displaced people (est.) = 15

4.1.16 Delta

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
4	2	2	1	1

Overview

Sub-basin size = largest in Myanmar
Location = Spanning several states encompassing much of the southern region

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	17%
Slopes<3 Elev<30m	65%
Slopes<3 Elev>30m	16%
Slopes>10 intermed rock	2%

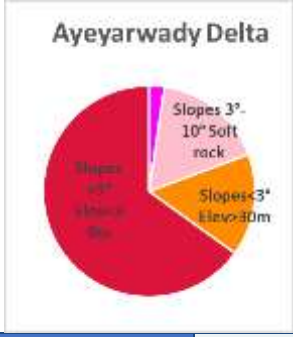
Physical	Area: 53,084 km^2 Average rainfall: 2,236 mm Average sub-basin outflow: 17,086.2 m3/s
Socio-economic	Population: 11,815,891 Ethnic diversity: Chini, Karen Economic activities: + Mining area: 2.4 km^2

	+ Navigable waterways: 7,885.3 km + Land use: Plantation (1.0%), Agriculture-Rainfed-Single (6.8%), Flood Plain-Single (0.7%), Flood Plain-Double (0.3%), Irrigated-Double (5.5%)
Administration	States/Regions: Ayeyarwady, Bago, Magway, Rakhine Major town/s: Bogale, Hinthada, Letpadan, Minhla, Pantanaw, Pathein, Pyay, Yangon
Hydropower development	Existing: 0 Under construction: 0 Planned: 0 Identified potential site: 0

Geomorphology and sediment	Rating	4

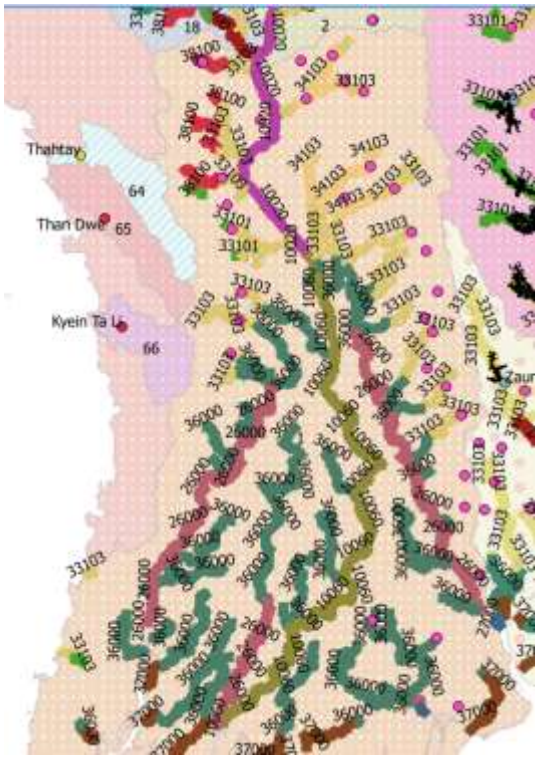
Sub-basin size: largest in the analysis including numerous small tributaries

- Predominantly flat-lying area of sediment storage and reworking, with gently sloping low hills in the west.
- High score due to a large inflow of water and high connectivity within the tributaries, even without considering the mainstem.
- NOTE: This score pertains only to the tributaries draining into the Ayeyarwady and does not apply to the mainstem, which is considered a special unit with a geomorphic value of 5.



Aquatic ecology and fisheries	Ecological value rating	2
	Human pressure rating	4

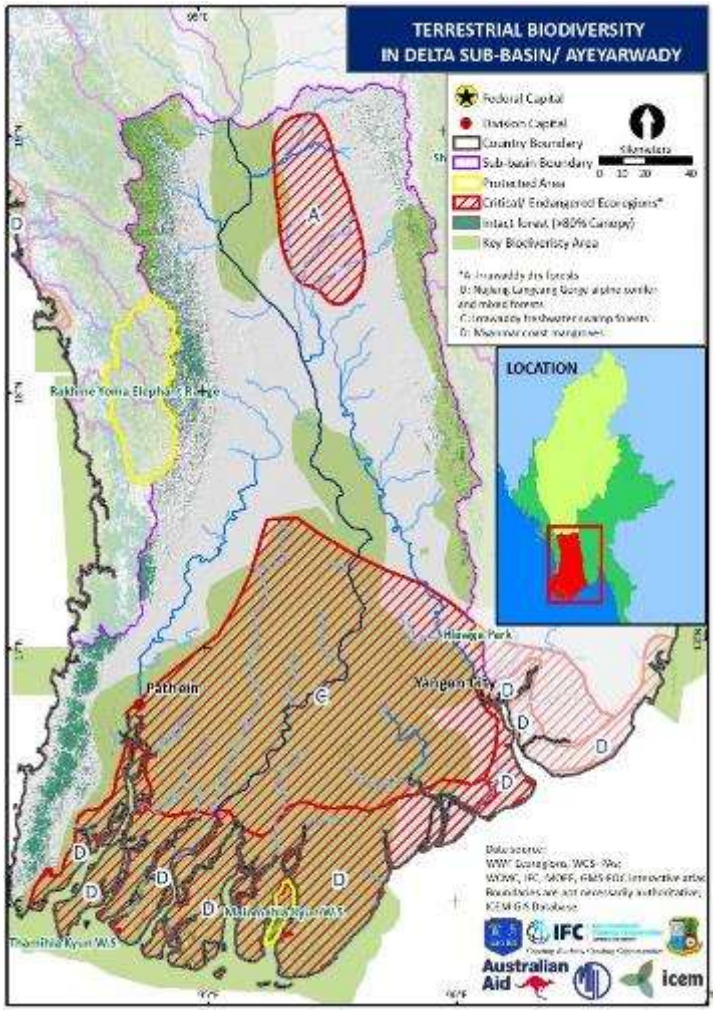
- The Ayeyarwady Delta is the final sub-basin where the river breaks up into about 6 distributary channels before reaching the sea. It is tidal and increasingly saline towards the sea.
- The mean annual flow at the point where the distributary channels start is about 16,000 m^3/sec, with a minimum flow of 2,288 m^3/sec
- The delta consists of 11 different river reach types of which 6 are rare. The first 116 km of the mainstem are in an anastomose channel, thereafter for 305 km the mainstem river reach type is characterized as flowing through the large delta. River reaches in the smaller channels in reaches above the main delta are the common Medium river, in moist broadleaf forest region at low elevation, with floodplains. Towards the bottom end nearest the sea, the medium river reaches flow through mangrove areas. There is a small area of karst in the north-west part of the delta sub-basin.
- The delta supports an important estuarine and coastal fishery, with mangrove areas which are important for fish and crustacean breeding. The migration routes for Hilsa and eel from the sea up the mainstem channels are very important. The main spawning area for Hilsa is around Hinthada and other distributary channels in the delta.
- Myanmar's most recent Ramsar site at Meinmahla Kyun is a mangrove area in the delta
- The human pressures are largely driven by the intensity of agriculture, with double and even triple cropping in many parts of the delta. The rural population density is high and there are many large towns throughout the delta, contributing domestic and industrial wastes and urban runoff. Cutting of



mangroves has contributed to degradation of the delta ecosystem.

- Note: The Ecological Value rating is for the tributaries only, not for mainstem reaches

Terrestrial biodiversity	Rating	2



Intact forest cover = 4%

KBA = 52%

Protected area = 0.3%

Critically endangered ecoregions = Irrawaddy dry forests (4.2%), Irrawaddy freshwater swamp forests (26%), and coast mangrove forests (17%), but these areas have been reduced to small pockets due to population pressure, agricultural encroachment, and forest clearing

- Despite its low biodiversity value rating of 2, this sub-basin receives a red star for the urgent need to safeguard what remains of its critically endangered ecoregions.

Social, livelihoods, and significant sites	Rating	1

- "Own account workers" (livelihood dependent on agriculture/NR) = 18% of the workforce
- Female-headed households = 22% of total households on average
- Avg. % of households owning a TV = 54%
- Ethnic minority groups = Chini and Karen

Conflict	Rating	1

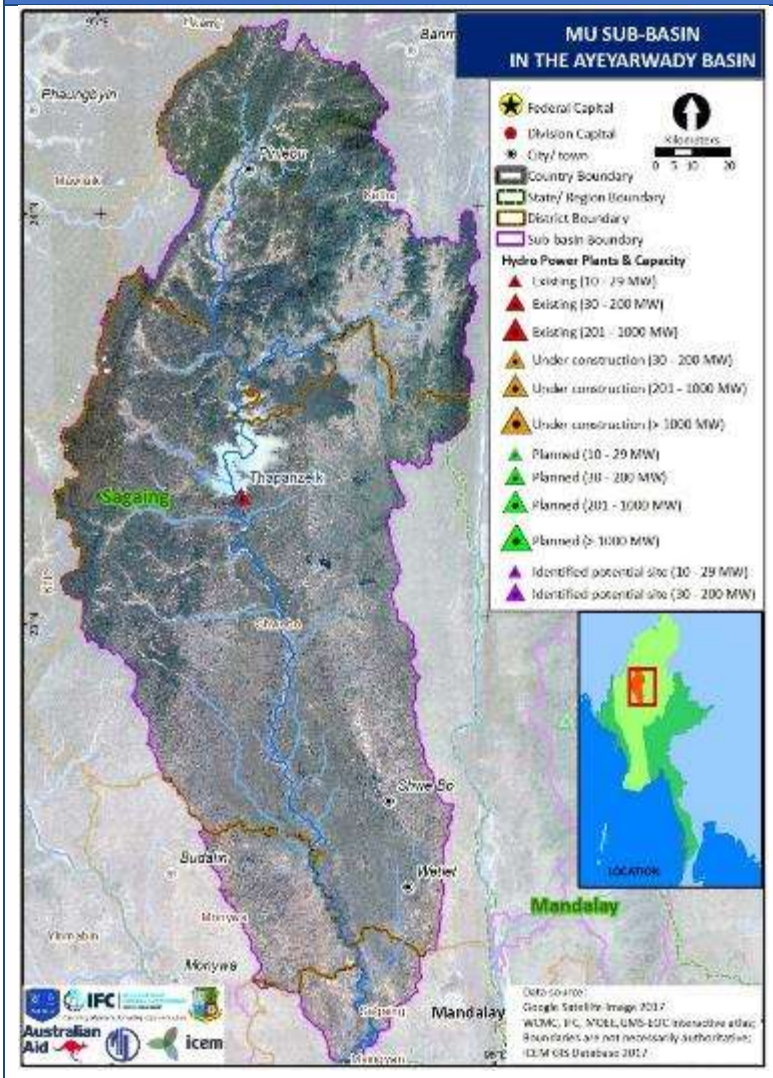
- Armed group presence = none to very low
- Est. battle deaths (1989-2015) = 17
- Media-reported armed conflict incidents (2012-2016) = 1
- Historical conflict-related displaced people (est.) = 0

4.1.17 Mu

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
3	1	1	5	1

Overview



Sub-basin size = relatively large
Location = Mandalay and Sagaing regions

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	33%
Slopes<3 Elev>30m	67%

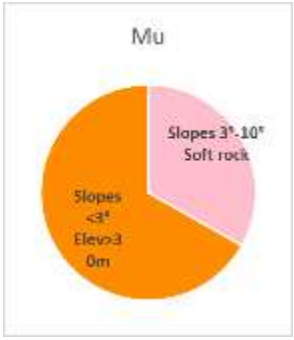
Physical	Area: 19,708 km^2 Average rainfall: 1,260 mm Average sub-basin outflow: 375.5 m^3/s
Socio-economic	Population: 1,953,363 Ethnic diversity: Lisu and Shan Economic activities: + Mining area: 33.7 km^2 (covers 0.17% of sub-basin) + Navigable waterways: None + Land use: Plantation (0%), Agriculture-Rainfed-Single (32.6%), Flood Plain-Double (0.1%), Irrigated-Single (0.8), Irrigated-Double (8.4%), Irrigated-Triple (0.2%)

Administration	States/Regions: Mandalay and Sagaing Major town/s: Pinlebu, Shwe Bo, and Wetlet
Hydropower development	Existing: 1 (Thapanzeik – 30 MW) Under construction: 0 Planned: 0 Identified potential site: 0

Geomorphology and sediment	Rating	3

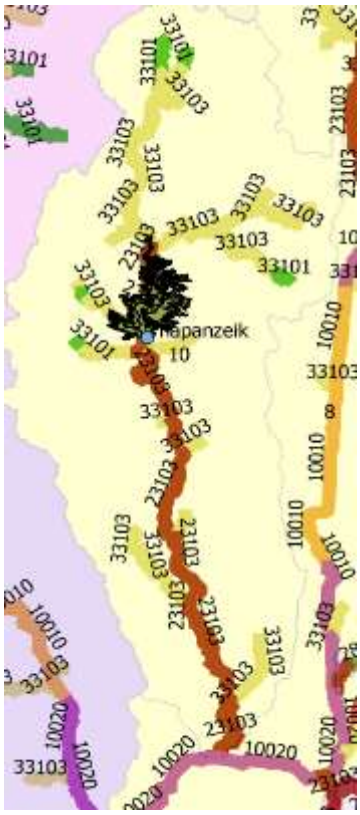
Sub-basin size: very large (82nd percentile)

- Drains low undulating hills with a broad valley floor, with similar attributes to the Middle Ayeyarwady mainstem.
- Regulated by a large hydropower and irrigation project in the upper catchment, and the entire catchment has been highly developed for agriculture.
- The impoundment has a potential residence time of ~170 days, suggesting the flow regime can be highly altered relative to natural flow patterns. The geomorphic rating is attributable to the large volume of water derived from the catchment, its high Strahler Order offset by the reduction in connectivity, sediment transport, and flow patterns attributable to the regulation.

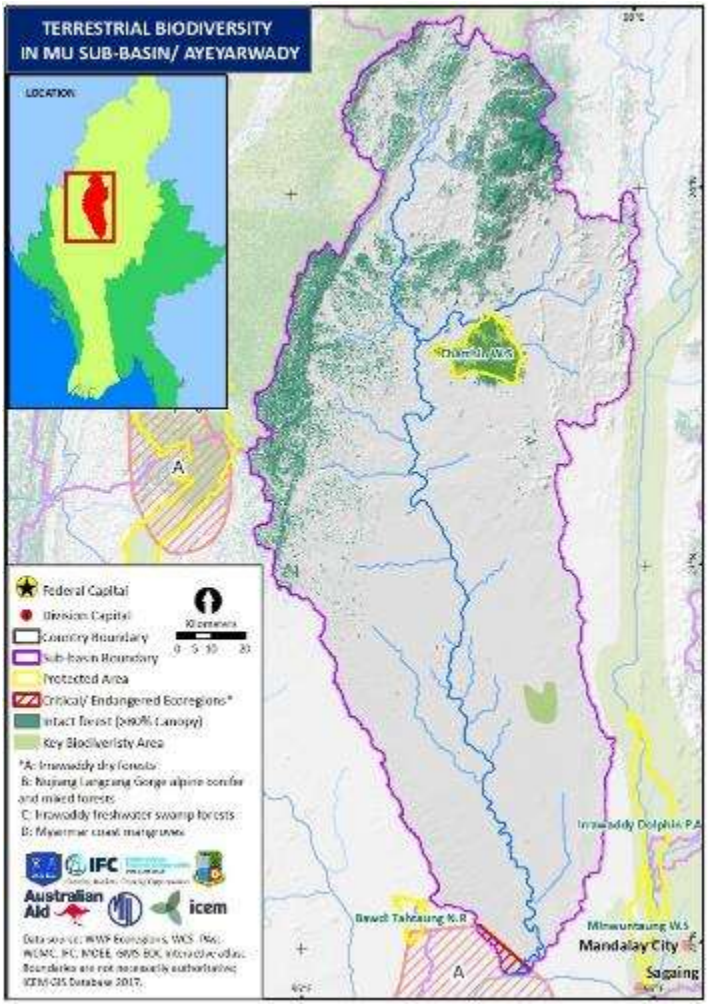


Aquatic ecology and fisheries	Ecological value rating	1
	Human pressure rating	5

- Flows from the north to south parallel to the Ayeyarwady mainstem between the confluences of the Myitnge and Chindwin rivers.
- Mean annual flows before the confluence are 373 m^3/sec with a minimum flow of 44 m^3/sec. At the confluence, total flows in the Ayeyarwady are 9,418 m^3/sec.
- Has three different river reach types: All of which are common, predominantly large and medium rivers, in moist broadleaf forest region at low elevation, with floodplains.
- Generally flat except in the upper catchment where the hills have been largely deforested and in the lower parts where the land is intensely cultivated.
- Has a very large combined irrigation and hydropower reservoir of Thapanzeik (30 MW) downstream, covering an area of 397 km^2 and a length of 42 km. The reservoir has a storage capacity of nearly six months, with a very high degree of flow regulation at the dam site.



Terrestrial biodiversity	Rating	1



Intact forest cover = 12%

KBA = 2%

Protected area = 1%

- The Chatthin Wildlife Sanctuary is home to several species of deer.

Critically endangered ecoregion = 0.5%

Social, livelihoods, and significant sites	Rating	5

- "Own account workers" (livelihood dependent on agriculture/NR) = 27% of the workforce
- Female-headed households = 25% of total households on average
- Avg. % of households owning a TV = 38%
- Ethnic minority groups = Lisu and Shan
- Sub-basin vulnerability rating = 5

Conflict	Rating	1

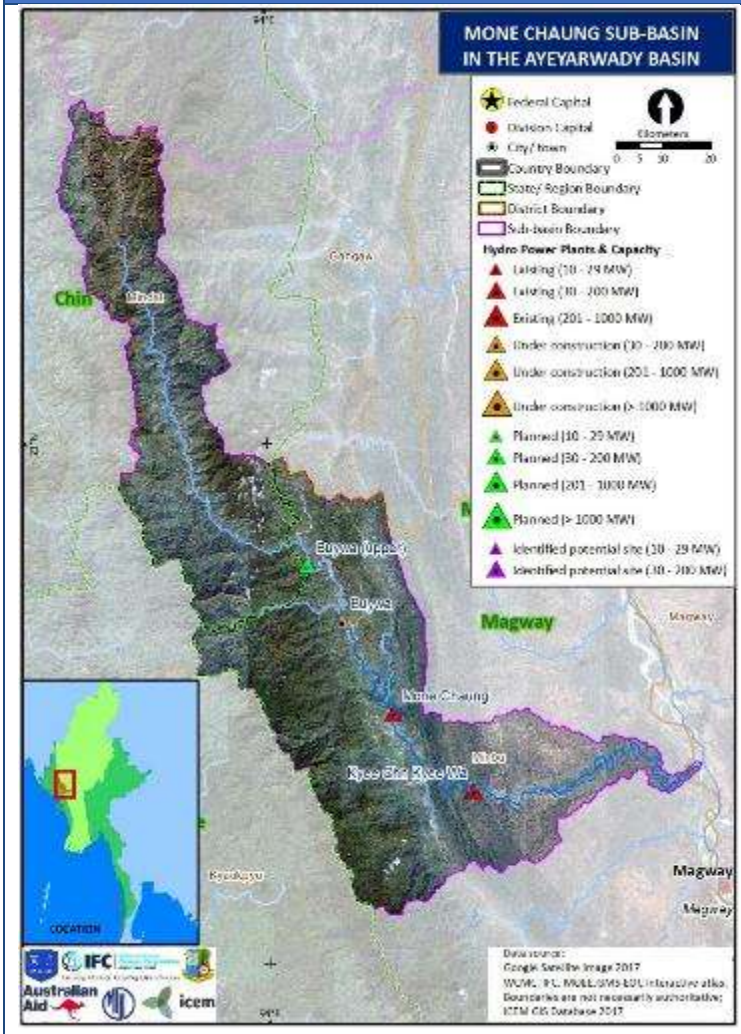
- Armed group presence: None or low
- Est. battle deaths (1989-2015) = 13
- Media-reported armed conflict incidents (2012-2016) = 0
- Historical conflict-related displaced people (est.) = 0

4.1.18 Mone Chaung

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
1	1	2	4	1

Overview



Sub-basin size = relatively small
Location = Chin and Rakhine states, western Myanmar

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	20%
Slopes<3 Elev>30m	13%
Slopes>10 intermed rock	67%

Physical	Area: 5,974 km^2 Average rainfall: 1,694 mm Average sub-basin outflow: 136.8 m^3/s
Socio-economic	Population: 232,711 Ethnic diversity: Chini Economic activities: + Mining area: No + Navigable waterways: None + Land use: Plantation (0%), Agriculture-Rainfed-Single (6%), Irrigated-Double (1.5%), Irrigated-Triple (0.1%)
Administration	States/Regions: Chin, Magway, and Rakhine Major town/s: Sidoktaya

Hydropower development	Existing: 2 (Kyee Ohn Kyee Wa – 74 MW, Mone Chaung – 75 MW) Under construction: 1 (Upper Buywa – 150 MW) Planned: 1 (Buywa – 42 MW) Identified potential site: 0

Geomorphology and sediment	Rating	1 (4)

Sub-basin size: small (35th percentile; maximum Strahler Order 2)

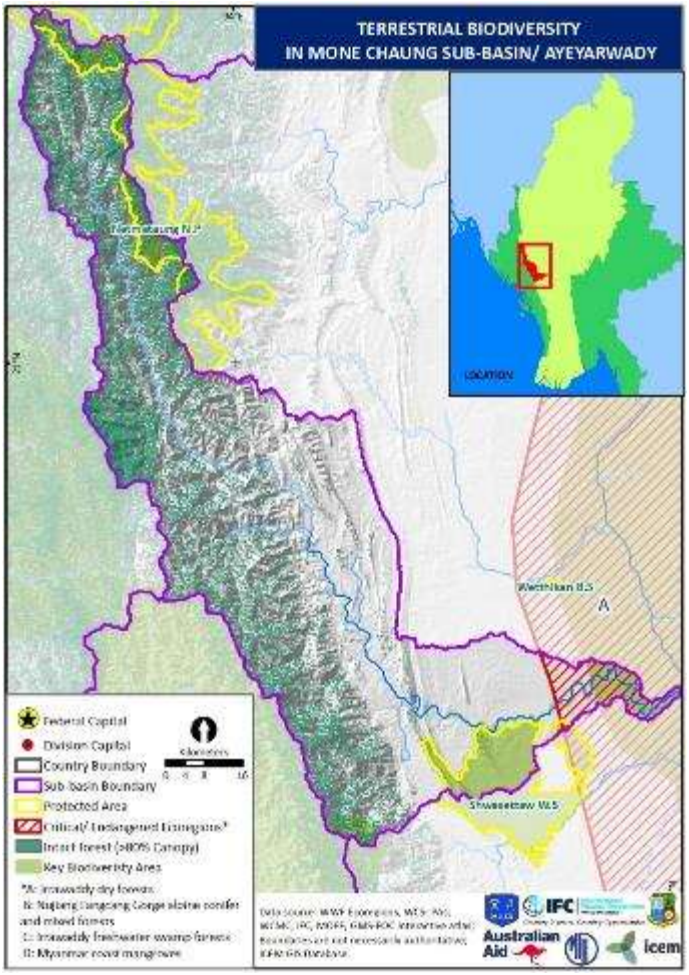
- Drains the eastern flanks of the Western Ranges, extending into the low-lying central basin.
- A cascade of three HPP developed on the mainstem of the tributary; each has a large impoundment – the most downstream project has potential water retention times of >50 days.
- The river's highly regulated nature disrupts its connectivity, sediment regime, and flow patterns, resulting in a low rating.

Aquatic ecology and fisheries	**Ecological value rating**	1
	Human pressure rating	4

- The Mone Chaung is a small tributary joining the right bank of the Ayeyarwady Lower just upstream of Magway. The mean annual flows at the confluence are 137 m^3/sec with minimum flows estimate at 13 m^3/sec
- It contains 6 river reach types of which 3 are rare, covering 27% of the reach lengths. Most of the reaches are Large and Medium rivers in moist broadleaf forest region at low elevation, with floodplains or at low gradient. The principal rare river reach type is Large river, in dry broadleaf forest region, with floodplains and sediment, reflecting the vegetation type in the Dry Zone.

- The river is not a noted area for endemic or threatened fish or other aquatic species, and there are no riverine KBAs in the sub-basin
- The principal human pressure upon aquatic ecology are the cascade of two existing HPPs – Kee Ohn Kee Wa (74 MW) with a 30-km reservoir and 45-day storage capacity, and an assessed medium impact upon aquatic ecology, and Mone Chaung HPP (75 MW) with a 20-km reservoir, and 76-day storage capacity. There are also two irrigation weirs downstream of the Kee Ohn Kee Wa dam, so the whole river is already significantly regulated – 32.5%.
- An additional HPP Buywa is under construction, and a fourth Upper Buywa is planned. Buywa HPP (42 MW) will have a 38 km^2 reservoir and is likely to increase the degree of regulation to about 36% in the river. With all four dams in place the Mone Chaung will be one of the most regulated, and reservoir inundated rivers in Myanmar.

Terrestrial biodiversity	Rating	2



Intact forest cover = 26%
KBA = 10%

- The region encompasses important habitats for many species including tigers, leopards, bears, and more.

Protected areas = 2

- The Shwesettaw Wildlife Sanctuary and the Natmataung National Park make up 7% of the sub-basin

Critically endangered ecoregions = 3%

- Irrawaddy dry forest ecoregion

Social, livelihoods, and significant sites	Rating	4

- "Own account workers" (livelihood dependent on agriculture/NR) = 25% of the workforce
- Female-headed households = 21% of total households on average
- Avg. % of households owning a TV = 26%
- Ethnic minority groups = Chini
- Sub-basin vulnerability rating = 4

Conflict	Rating	1

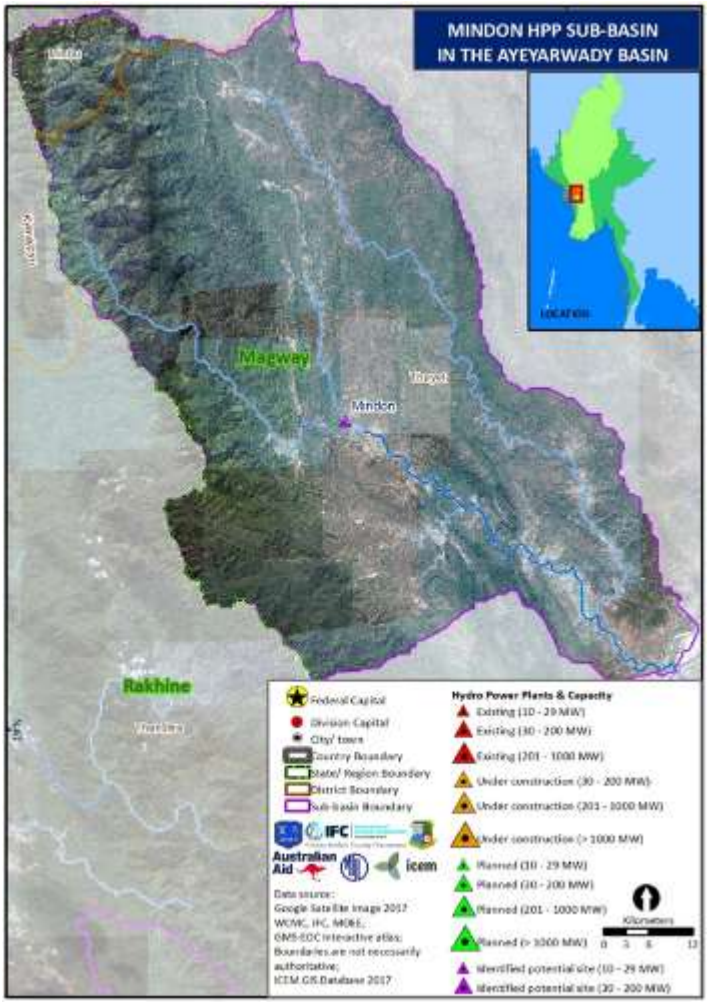
- Armed group presence: None or low
- Est. battle deaths (1989-2015) = 0
- Media-reported armed conflict incidents (2012-2016) = 0
- Historical conflict-related displaced people (est.) = 4

4.1.19 Mindon

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
1	2	2	4	1

Overview



Sub-basin size = relatively small

Location = Rakhine state, western Myanmar

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	54%
Slopes<3 Elev>30m	15%
Slopes>10 intermed rock	31%

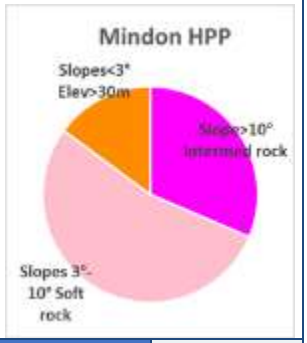
Physical	Area: 4,445 km^2 Average rainfall: 1,385 mm Average sub-basin outflow: 173.6 m^3/s
Socio-economic	Population: 20,039 Ethnic diversity: Chini Economic activities: + Mining area: No + Navigable waterways: None + Land use: Plantation (0%), Agriculture-Rainfed-Single (7.2%), Rainfed-Double (0.1%), Irrigated-Single (0.4), Irrigated-Triple (0.5%)
Administration	States/Regions: Magway and Rakhine Major town/s: Mindon

Hydropower development	Existing: 0 Under construction: 0 Planned: 0 Identified potential site: 1 (Mindon – 18 MW)

Geomorphology and sediment	Rating	(4)

Sub-basin size: small (30th percentile; Strahler Order 2 tributary)

- Drains the steep western ranges before flowing through an area of alluvial fill and reworking; situated in the Ayeyarwady Lower sub-basin.
- Its low geomorphology rating is attributable to its small size and low Strahler Order.
- If the Mindon HPP was considered as part of the Ayeyarwady Lower sub-basin, it still would not diminish the geomorphology rating of this larger unit, i.e. 4.

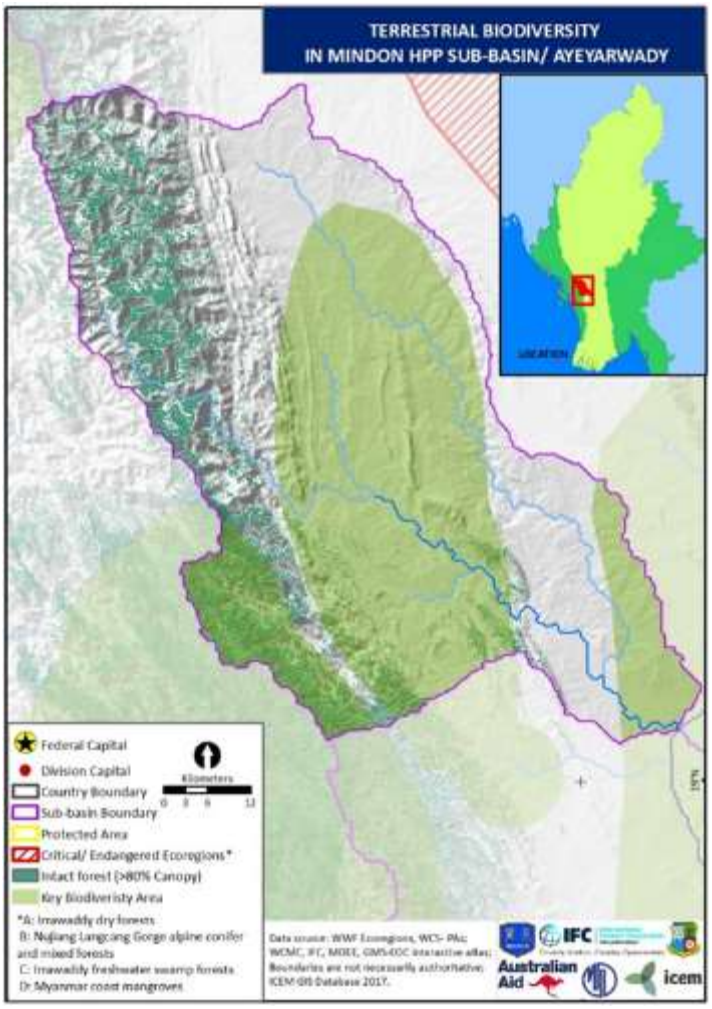


Aquatic ecology and fisheries	Ecological value rating	2
	Human pressure rating	3

- The Man Chaung sub-basin is the next tributary in the right bank of the Ayeyarwady Lower below Mone Chaung. It contains six river reach types, but only one is rare, making up 2% of the river reach lengths. However, it has the only karst river reach in the Lower Ayeyarwady, with about 45% of its reach lengths being large and medium rivers in karst region at low elevation.
- The mean annual flows at the confluence with the Ayeyarwady are 172 m^3/sec with minimum flows estimated at 11 m^3/sec.
- No aquatic endemic or threatened species and only one mainly terrestrial KBA, the Man Chaung watershed.

- Human pressures generally relate to increasing agricultural intensity and rural population density.
- Mindon HPP (18 MW) is the only hydropower project proposed for this sub-basin.

Terrestrial biodiversity	Rating	2



Intact forest cover = 13%

KBA = 49%, home to several endangered species of birds and threatened animals including the white-handed gibbon

Social, livelihoods, and significant sites	Rating	4

- "Own account workers" (livelihood dependent on agriculture/NR) = 35% of the workforce
- Female-headed households = 18% of total households on average
- Avg. % of households owning a TV = 37%
- Ethnic minority groups = Chini
- Sub-basin vulnerability rating = 4

Conflict	Rating	1

- Armed group presence: none or low
- Est. battle deaths (1989-2015) = 0
- Media-reported armed conflict incidents (2012-2016) = 0
- Historical conflict-related displaced people (est.) = 0

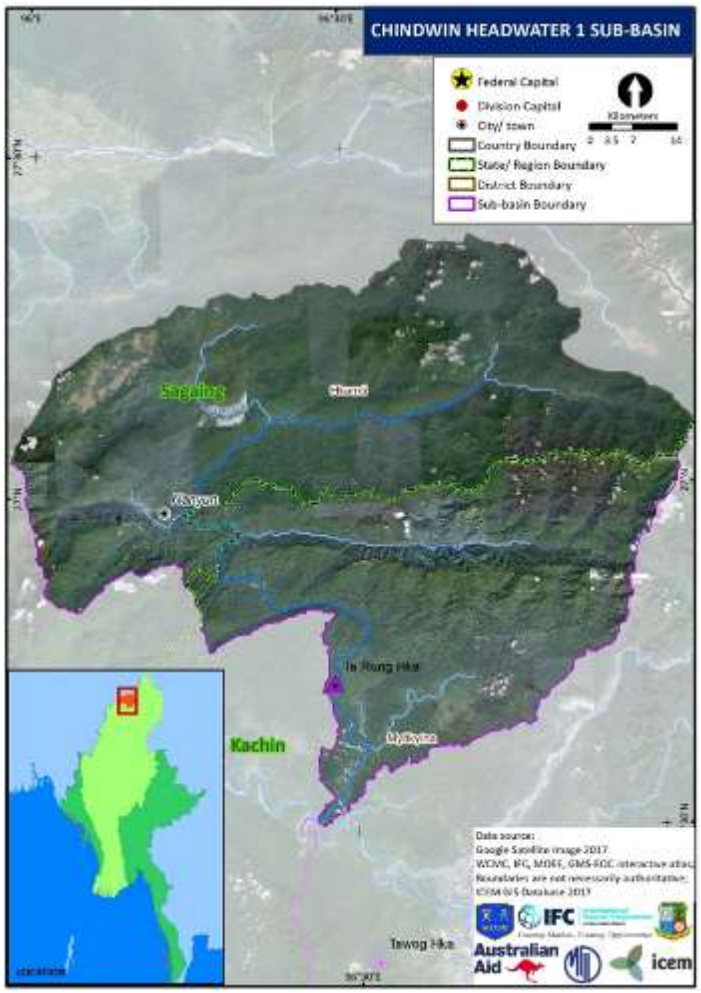
4.2 Chindwin Basin

4.2.1 Chindwin Headwaters 1

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
3	4	5	1	2

Overview



Sub-basin size = medium

Location = Kachin State adjacent to Myanmar's northern border, which it shares with India

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	6%
Slopes<3 Elev>30m	7%
Slopes>10 intermed rock	87%

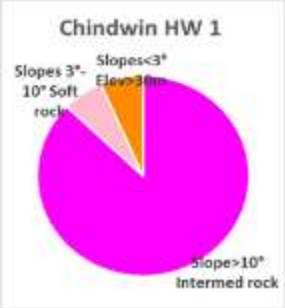
Physical	Area: 5,977 km^2 Average rainfall: 2,957 mm Average sub-basin outflow: 256.8 m^3/s
Socio-economic	Population: 51,980 Ethnic diversity: Kachins (Singpho) and Nagas (Ao, Sema, Lhota, Rengma, etc.) Economic activities: + Mining area: No + Navigable waterways: None + Land use: Plantation (0%), Agriculture-Irrigated-Double (0.2%)
Administration	States/Regions: Kachin and Sagaing Major town/s: Nanyun and Pansaung

Hydropower development	Existing: 0 Under construction: 0 Planned: 0 Identified potential site: 1 (Ta Rung Hka – 150 MW)

Geomorphology and sediment	Rating	3

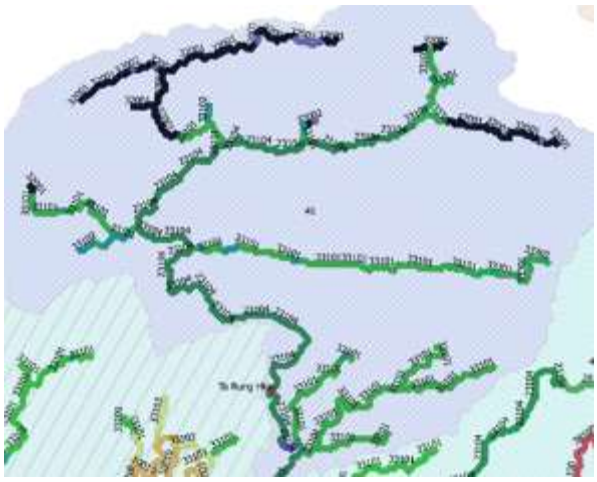
Sub-basin size: small (37th percentile; Strahler Order 2)

- Steep, structurally controlled sub-basin in the headwaters of the Chindwin with narrow valleys.
- Lies within steep erosive strata, receives high rainfall, and potentially provides a large sediment input to the Chindwin.
- The moderate geomorphology rating is attributable to its small size and low Strahler Order.



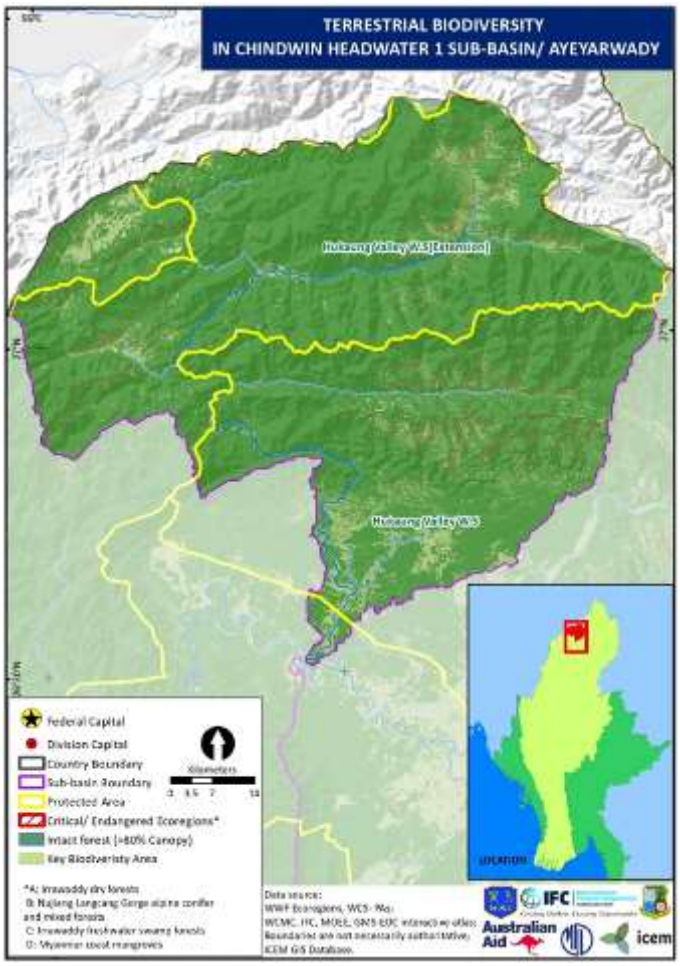
Aquatic ecology and fisheries	Ecological value rating	4
	Human pressure rating	1

- Consists of several branches of relatively consistent river reach diversity with eight river reach types, six of which are rare. The predominant reach type is large rivers in moist broadleaf forest region at low elevation, with sediment. The upper river reaches are mainly medium rivers in moist broadleaf forest region at low elevation, with low gradient, but there are also medium rivers in coniferous region, with both low and high gradient, in the highest reaches. There is no karst limestone.



- The mean annual flows are 564 m^3/sec with a minimum flow of 72 m^3/sec.
- Most of the sub-basin lies within the Hukaung Valley Wildlife Sanctuary and KBA, which is important for water birds as well as terrestrial biodiversity. The Chindwin headwaters are recognized as important for endemic fish species.
- Human pressures are very low; forest cover has remained quite high with low population density and little agriculture and mining activities. These factors contribute to its high ecological value.

Terrestrial biodiversity	Rating	5



Intact forest cover = 85%

KBA = 100%; the whole sub-basin falls within a KBA essential for tigers and several species of birds

Protected areas = 93%; the Hukaung Valley Wildlife Sanctuary is among six out of 58 sub-basins receiving the highest biodiversity value rating

Social, livelihoods, and significant sites	Rating	1

- "Own account workers" (livelihood dependent on agriculture/NR) = 22% of the workforce
- Female-headed households = 13% of total households on average
- Avg. % of households owning a TV = 4%
- Ethnic minority groups = Kachins (Singpho) and Nagas (Ao, Sema, Lhota, Rengma, etc.)
- Sub-basin vulnerability rating = 1

Conflict	Rating	2

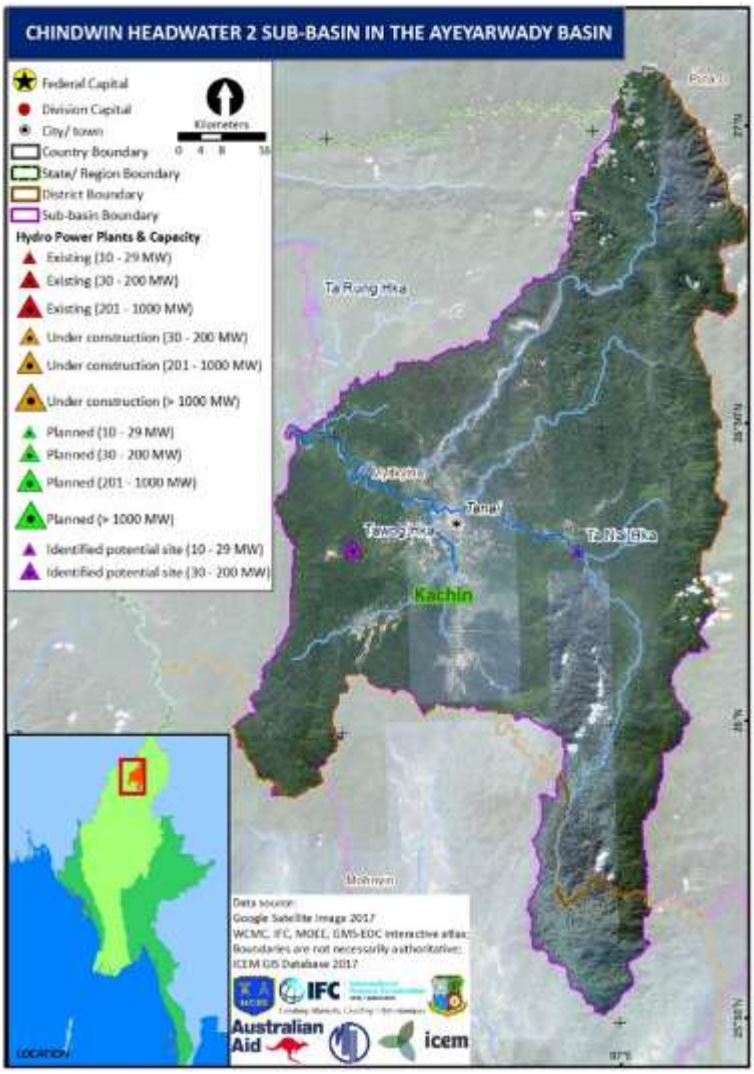
- Armed group presence: Naga SAZ and KIO active in parts of the sub-basin
- Est. battle deaths (1989-2015) = 1
- Media-reported armed conflict incidents (2012-2016) = 0
- Historical conflict-related displaced people (est.) = 0

4.2.2 Chindwin Headwaters 2

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
2	5	5	2	3

Overview



Sub-basin size = medium

Location = immediately south of Chindwin Headwaters 1, northern Myanmar

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	27%
Slopes<3 Elev>30m	28%
Slopes>10 intermed rock	45%

Physical	Area: 7,813 km^2 Average rainfall: 3,018 mm Average sub-basin outflow: 669.6 m^3/s
Socio-economic	Population: 60,019 Ethnic diversity: Kachins (Singpho) and Khun Economic activities: + Mining area: 26.7 km^2 (covers 0.34% of sub-basin) + Navigable waterways: None + Land use: Plantation (0%), Agriculture-Irrigated-Double (0.2%)
Administration	States/Regions: Kachin and Sagaing Major town/s: Tanai

Hydropower development	Existing: 0 Under construction: 0 Planned: 0 Identified potential site: 2 (Ta Nai Hka – 15 MW, Tawog Hka – 50 MW)

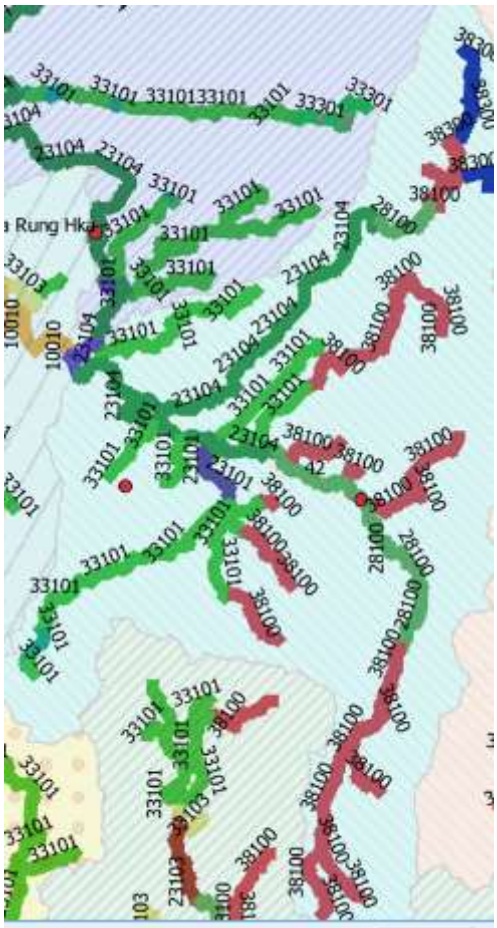
Geomorphology and sediment	Rating	2

Sub-basin size: medium (40th percentile; Strahler Order 3)

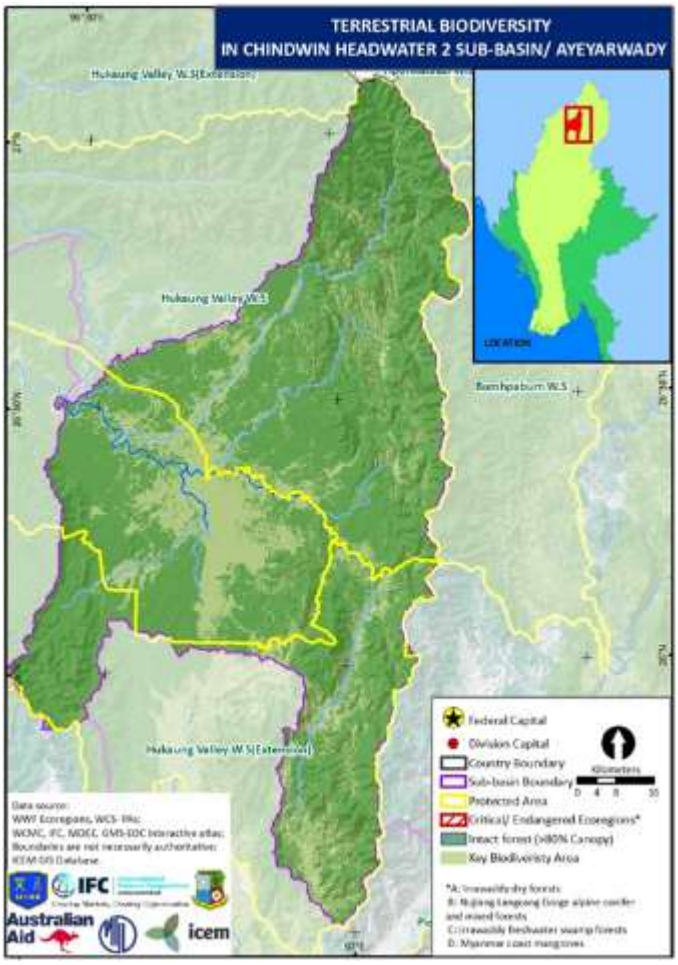
- The eastern headwater drains a large area of steep erodible strata.
- Contains a large, low-lying flat central valley where sediment is stored and the river meanders.
- The river has a Strahler Order of 3 but not much of its catchment area is likely to be a source of sediment. The small sub-basin size and low sediment input contribute to its low geomorphology rating.
- No existing HPP.

Aquatic ecology and fisheries	Ecological value rating	5
	Human pressure rating	1

- About half of its river reaches run through karst limestone at low and high elevation, especially in the upper part, similar to the Mali Hka sub-basin; its lower river reaches tend to be similar to the Headwaters 1 sub-basin, predominantly large rivers in moist broadleaf forest region at low elevation, with sediment.
- Has eight river reach types, four of which are rare, making up 8% of the river reaches.
- The mean annual flow before the confluence of the two headwater rivers is 670 m^3/sec, with a minimum flow of 65 m^3/sec. After the confluence, the mean annual flow is 1,232 m^3/sec, i.e. in the Tanai River.
- Recognized as important endemic areas for fish and other aquatic flora and fauna.
- The upper eastern part lies within the Bumphabum KBA, which is recognized for water birds; the Hukaung Valley Wildlife Sanctuary and the Hukaung extension KBA also cover a large part of the sub-basin. The Tanai River, a fully riverine KBA, extends from the lower lying part of the river reaches beyond the confluence with the Chindwin headwater 1 sub-basin.
- Human pressure in the sub-basin is very low, with extensive high forest cover, low rural population, and low agricultural intensity. Mining activity is developing and may affect river health in the future.



Terrestrial biodiversity	Rating	5



Intact forest cover = 72%

KBA = 99%; critical habitat for tigers, leopards, elephants, and several species of birds

Protected areas = 73%; Contains the Hukaung Valley, the Hponkanrazi, and the Bumhpabum wildlife sanctuaries

- Among six out of 58 sub-basins that received a biodiversity value rating of 5

Social, livelihoods, and significant sites	Rating	2

- "Own account workers" (livelihood dependent on agriculture/NR) = 35% of the workforce
- Female-headed households = 17% of total households on average
- Avg. % of households owning a TV = 52%
- Ethnic minority groups = Kachins (Singpho) and Khun
- Sub-basin vulnerability rating = 2

Conflict	Rating	3

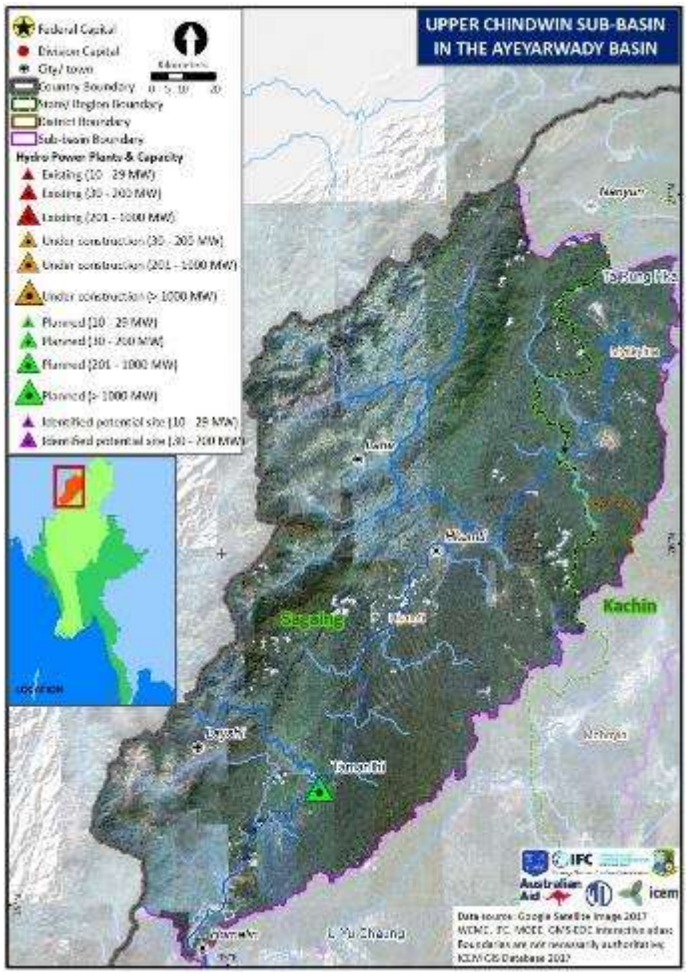
- Armed group presence: KIO active in much of the sub-basin
- Est. battle deaths (1989-2015) = 5
- Media-reported armed conflict incidents (2012-2016) = 5
- Historical conflict-related displaced people (est.) = 134

4.2.3 Chindwin Upper

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
5	3	4	4	2

Overview



Sub-basin size = 7th largest

Location = Kachin state, northern Myanmar, bordering India

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	34%
Slopes<3 Elev>30m	8%
Slopes>10 intermed rock	58%

Physical	Area: 23,314 km^2 Average rainfall: 2,539 mm Average sub-basin outflow: 3,401.6 m^3/s
Socio-economic	Population: 112,506 Ethnic diversity: Kachins (Singpho), Nagas (Ao, Sema, Lhota, Rengma, etc.), and Shan Economic activities: + Mining area: 76.5 km^2 (covers 0.33% of sub-basin) + Navigable waterways: 184.5 km + Land use: Plantation (0.1%), Agriculture-Rainfed-Single (0.6%), Irrigated-Double (0.2%)
Administration	States/Regions: Kachin and Sagaing Major town/s: Hkamti, Homalin, Lahe, and Layshi

Hydropower development	Existing: 0 Under construction: 0 Planned: 1 (Tamanthi – 1,200 MW) Identified potential site: 0

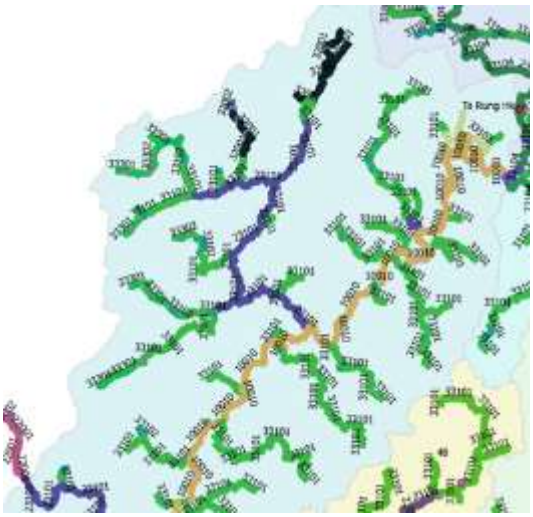
Geomorphology and sediment	Rating	5

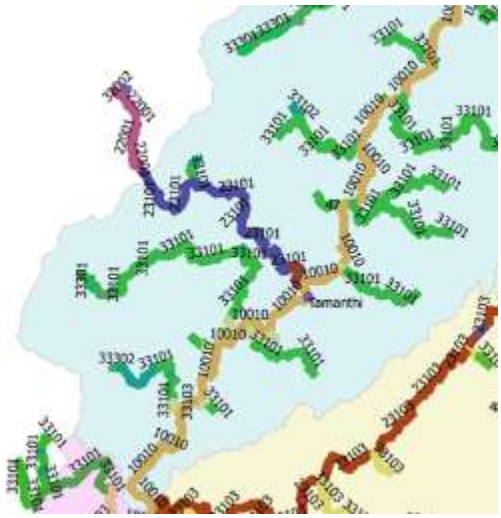
Sub-basin size: very large (89th percentile; complex Strahler Order 3 rivers)

- Receives high rainfall and drains the erodible, steeply sloping Western Ranges.
- The sub-basin is well forested with low levels of development and no existing HPPs.
- The geomorphology rating of 5 reflects its large size, complex rivers, and high flow and sediment input.
- NOTE: This rating pertains only to the tributaries draining into the Chindwin and does not apply to the mainstem Chindwin, which is considered a special unit with a geomorphic value of 5.

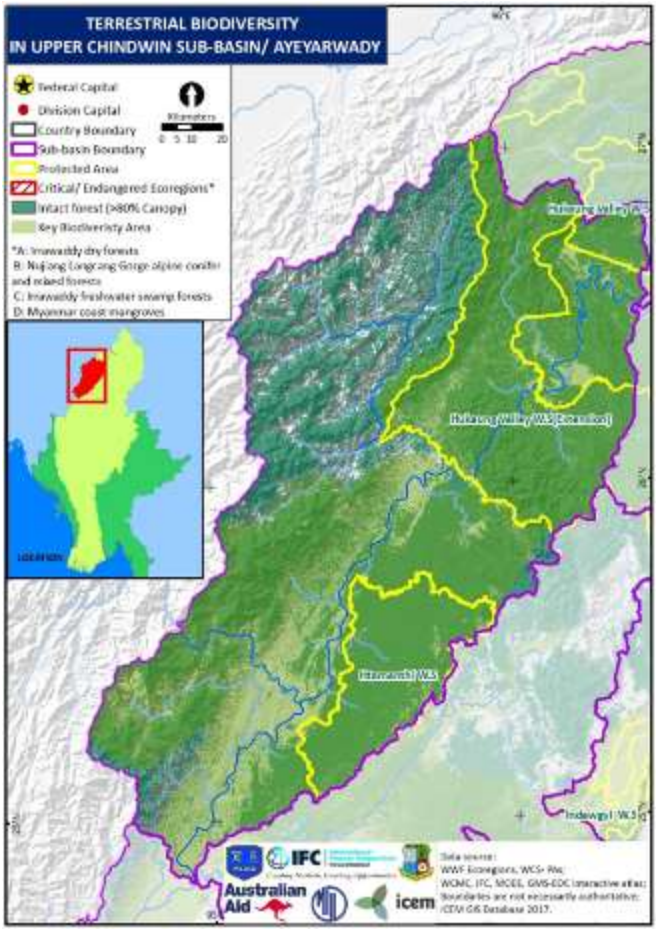
Aquatic ecology and fisheries	Ecological value rating	3
	Human pressure rating	1

- The large sub-basin has a 390-km mainstem (over 1,000 m3/sec) flowing through rock-cut river channel. It contains 11 different river reach types, seven of which are rare, covering 29% of the reach lengths, but there is no karst limestone reaches.
- The mean annual flow at the start is 1,232 m^3/sec and increases to 3,402 m^3/sec, with a minimum flow of 336 m^3/sec at the end.
- The mainstem is an important fish migratory route, while the western tributaries in the Chin hills are recognized for endemic fish species. The tributary flowing in from Nagaland in India hosts threatened turtle species.
- The upper sub-basin lies within the Hukaung Valley Wildlife Sanctuary; downstream of this lies the Htamunthi Wildlife Sanctuary, which follows the Chindwin Valley. Both are important habitats for water birds and turtles.
- Human pressures are generally very low, except some forest clearance and significant mining activity along the river valley. The river health status is considered good.
- A proposed hydropower dam at Tamanthi has been postponed.
- Note: Ecological value rating based upon tributaries only, not mainstem reaches





Terrestrial biodiversity	Rating	4



Intact forest cover = 73%

KBA = 73%; a habitat for several endemic species including Burmese-roofed turtles and Burmese peacocks

Protected areas = 30%; include the Hukaung Valley and the Htamanthi wildlife sanctuaries

Social, livelihoods, and significant sites	Rating	4

- "Own account workers" (livelihood dependent on agriculture/NR) = 26% of the workforce
- Female-headed households = 18% of total households on average
- Avg. % of households owning a TV = 21%
- Ethnic minority groups = Kachins (Singpho), Nagas (Ao, Sema, Lhota, Rengma, etc.), and Shan
- Sub-basin vulnerability rating = 4

Conflict	Rating	2

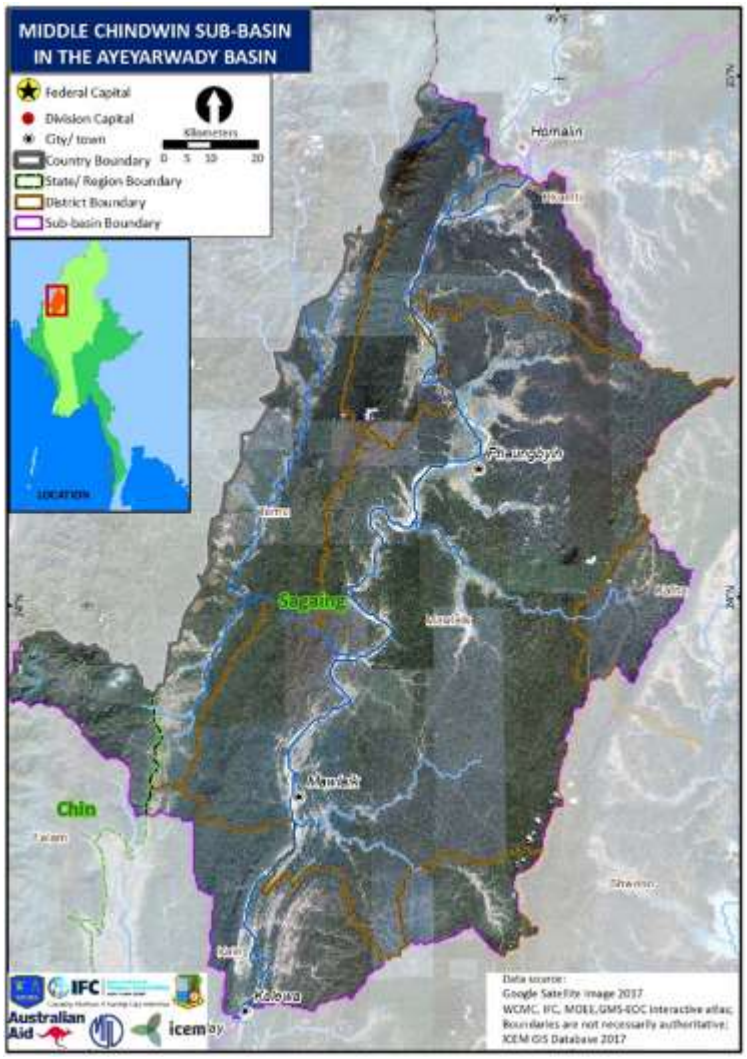
- Armed group presence: Some areas occupied by Naga SAZ and others influenced by KIO
- Est. battle deaths (1989-2015) = 2
- Media-reported armed conflict incidents (2012-2016) = 2
- Historical conflict-related displaced people (est.) = 266

4.2.4 Chindwin Middle

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
4	3	3	4	1

Baseline Value Ratings



Sub-basin size = Large

Location = Sagaing region, northwestern Myanmar, bordering India

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	86%
Slopes<3 Elev>30m	11%
Slopes>10 intermed rock	3%

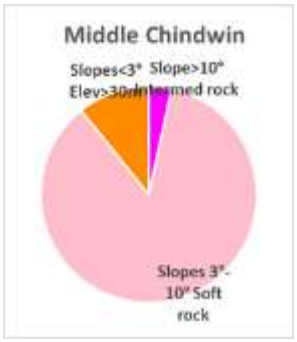
Physical	Area: 14,376 km^2 Average rainfall: 1,898 mm Average sub-basin outflow: 4,606.5 m^3/s
Socio-economic	Population: 278,877 Ethnic diversity: Chini and Shan Economic activities: + Mining area: 33.3 km^2 (covers 0.23% of sub-basin) + Navigable waterways: 221.8 km + Land use: Plantation (0%), Agriculture-Rainfed-Single (6.7%), Flood Plain-Single (0.1%), Flood Plain-Double (0.3%), Irrigated-Single (0.2%), Irrigated- Double (1.4%), Irrigated-Triple (0.1%)

Administration	States/Regions: Chin and Sagaing Major town/s: Kalewa, Mawlaik, and Phaungbyin
Hydropower development	Existing: 0 Under construction: 0 Planned: 0 Identified potential site: 0

Geomorphology and sediment	Rating	4

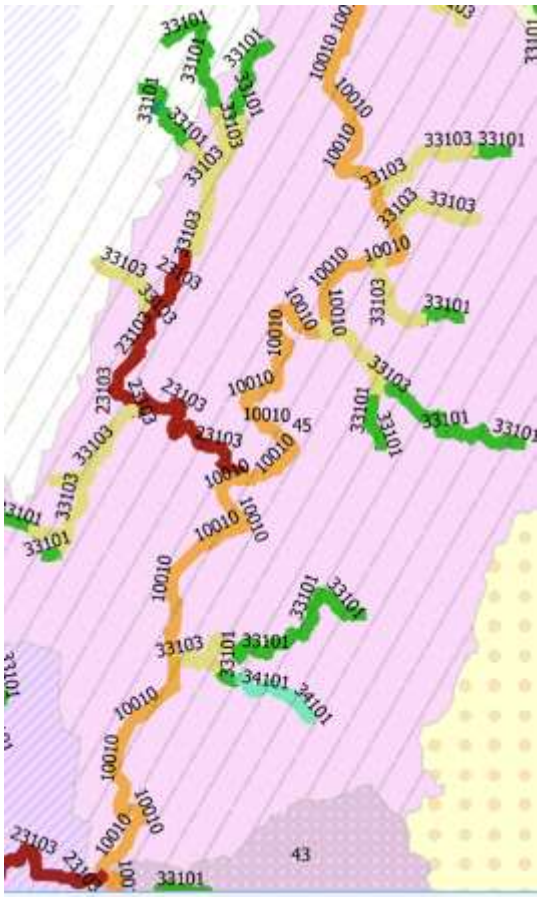
Sub-basin size: large (68th percentile; Strahler Order 3 tributaries)

- Most of the basin is underlain by the Western Ranges and is likely to contribute high sediment loads during periods of intensive rainfall; structurally controlled river network that drains into the Chindwin mainstem.
- No hydropower developments in the sub-basin or upstream.
- The sub-basin is largely forested with some agriculture in the lower flat areas, resulting in its high geomorphic rating.
- NOTE: This rating does not apply to the mainstem Chindwin, which is considered a special unit with a geomorphic value of 5.

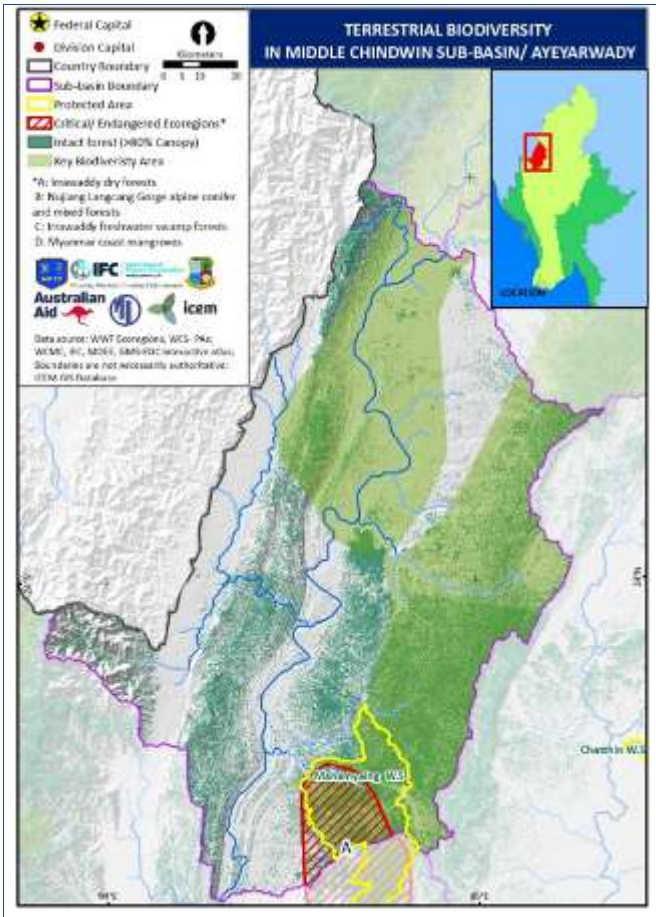


Aquatic ecology and fisheries	Ecological value rating	3
	Human pressure rating	2

- Extends from the confluence with the Uyu River to that with the Manipur river. The mean annual flows after these two points are 4,099 m^3/sec and 5,837 m^3/sec.
- The mainstem has 280 km of rock-cut river channel; the tributaries have five other river reach types, two of which are rare covering only 3% of the reach lengths. The characteristic river reach types are large and medium rivers in moist broadleaf forest region at low elevation, with floodplains, and medium river in moist broadleaf forest region at low elevation, with low gradient; all of them are common.
- A small part of the catchment in the hills marks the border with India.
- The mainstem is an important fish migratory route and the western tributaries lie within an area recognized for endemic fish species. The Chindwin Middle – together with the associated wetlands in the upstream floodplains – is now a newly recognized riverine KBA.
- Human pressures are generally low despite some agricultural and alluvial gold mining activities in the floodplains.
- Note: Ecological value rating based upon tributaries only, not mainstem reaches



Terrestrial biodiversity	Rating	3



Intact forest cover = 30%

KBA = nearly 48%, including wetlands important for fish migration and several species of mammals such as gibbons, serows, and elephants

Critically endangered ecoregion = 4%; the Irrawaddy dry forest

Social, livelihoods, and significant sites	Rating	4

- "Own account workers" (livelihood dependent on agriculture/NR) = 27% of the workforce
- Female-headed households = 23% of total households on average
- Avg. % of households owning a TV = 42%
- Ethnic minority groups = Chini and Shan
- Sub-basin vulnerability rating = 4

Conflict	Rating	1

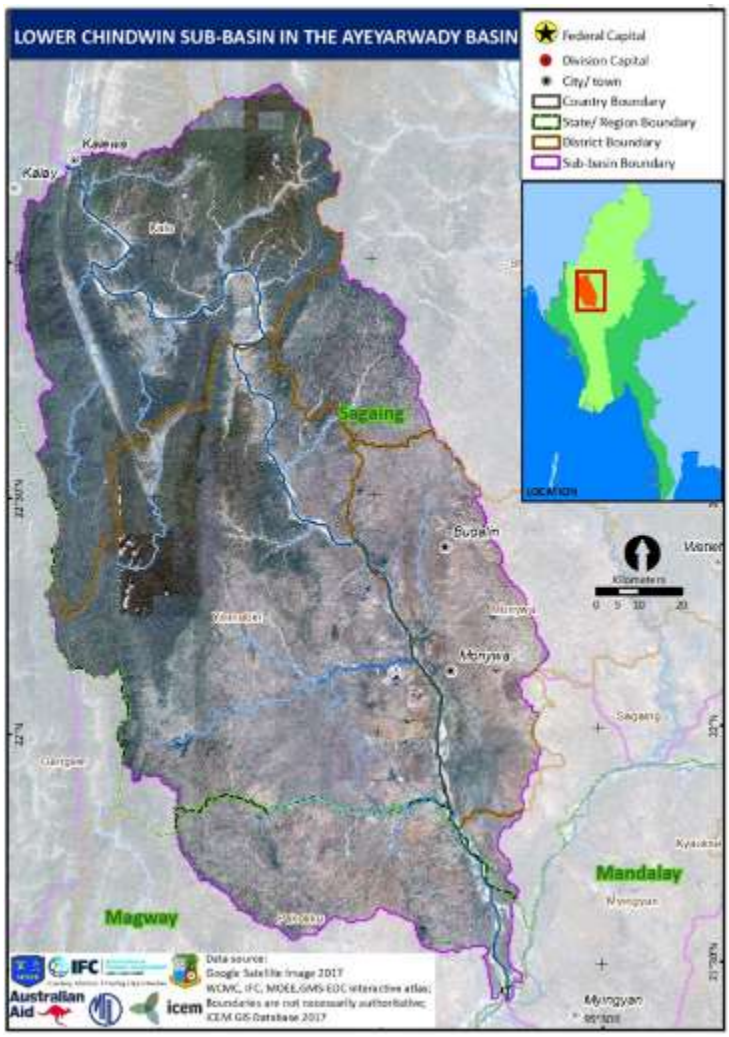
- Armed group presence: None or low
- Est. battle deaths (1989-2015) = 0
- Media-reported armed conflict incidents (2012-2016) = 1
- Historical conflict-related displaced people (est.) = 0

4.2.5 Chindwin Lower

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
2	1	1	5	2

Overview



Sub-basin size = relatively large

Location = spans multiple states in western Myanmar

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	34%
Slopes<3 Elev>30m	66%

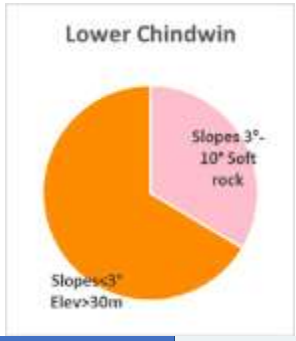
Physical	Area: 16,621 km^2 Average rainfall: 1,113 mm Average sub-basin outflow: 5,563.9 m^3/s
Socio-economic	Population: 3,563,016 Ethnic diversity: Burmese Economic activities: + Mining area: 40.6 km^2 (covers 0.24% of sub-basin) + Navigable waterways: 261 km + Land use: Plantation (0%), Agriculture-Rainfed-Single (38.7%), Flood Plain-Single (0.1%), Flood Plain-Double (0.2%), Irrigated-Single (0.3), Irrigated-Double (2%), Irrigated-Triple (0.5%)

Administration	States/Regions: Magway, Mandalay, and Sagaing Major town/s: Budalin and Monywa
Hydropower development	Existing: 0 Under construction: 0 Planned: 0 Identified potential site: 0

Geomorphology and sediment	Rating	2

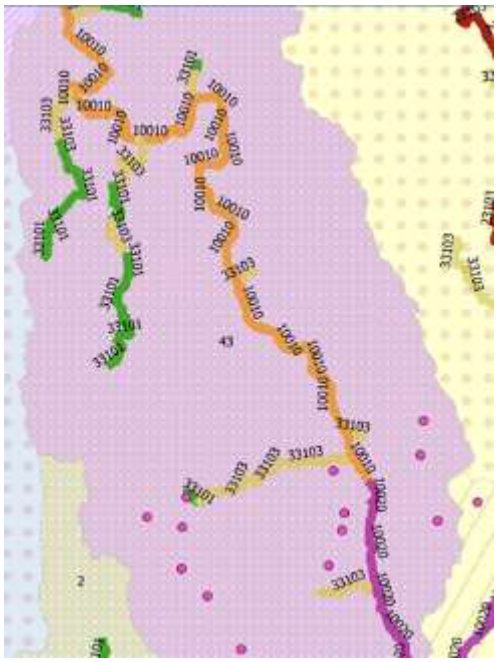
Sub-basin size: large (74th percentile; low Strahler Order rivers)

- Numerous rivers flow directly to the Chindwin mainstem; sediment deposition has resulted in a broad, flat central valley through which the mainstem flows and re-works sediments.
- Low sediment inputs and a low connectivity score due to the low-order tributaries in the sub-basin contribute to its geomorphology rating of 2.
- No existing hydropower plants.
- NOTE: This rating does not apply to the mainstem Chindwin, which is considered a special unit with a geomorphic value of 5.

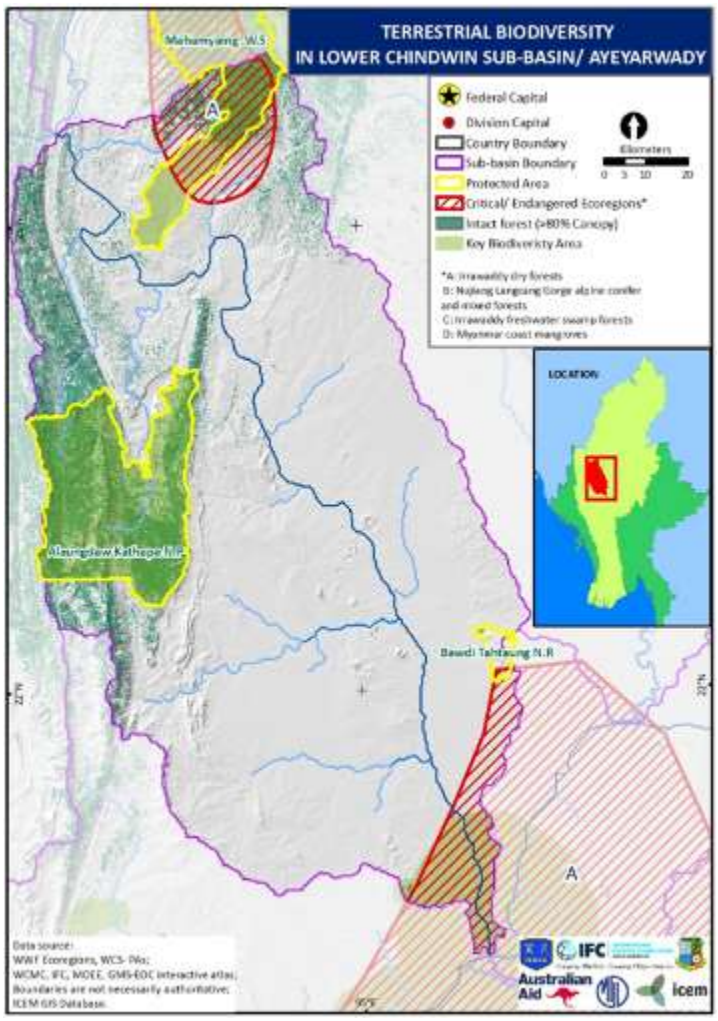


Aquatic ecology and fisheries	Ecological value rating	1
	Human pressure rating	3

- A relatively flat sub-basin with the Chindwin mainstem consisting predominantly of 236 km of rock-cut river channel that changes to an anastomosing channel about 82 km before the Ayeyarwady confluence.
- Several small tributaries enter from the right bank, consisting of medium rivers in moist broadleaf forest region at low elevation, with low gradient and with floodplains.
- The mean annual flow before the confluence with the Ayeyarwady is 5,664 m^3/sec, increasing the Ayeyarwady's downstream flow to 15,053 m^3/sec. The minimum flows are estimated at 538 m^3/sec.
- The mainstem is recognized as an important migratory route for fish with the presence of some threatened fish species. There are no riverine KBAs.
- Human pressures come from increasing agricultural intensity, as reflected by the 13 irrigation reservoirs and weirs in the lower part of the sub-basin. Mining intensity is moderate.
- Note: Ecological value rating based upon tributaries only, not mainstem reaches



Terrestrial biodiversity	Rating	1



Intact forest cover = 13%

KBA = 14%; a habitat for gibbons, serows, and elephants

Protected areas = 9%; contains the Alaungdaw Kathapa National Park

Critically endangered ecoregion = 8%; the Irrawaddy dry forest

Social, livelihoods, and significant sites	Rating	5

- "Own account workers" (livelihood dependent on agriculture/NR) = 25% of the workforce
- Female-headed households = 26% of total households on average
- Avg. % of households owning a TV = 35%
- Ethnic minority groups = None
- Sub-basin vulnerability rating = 5

Conflict	Rating	1

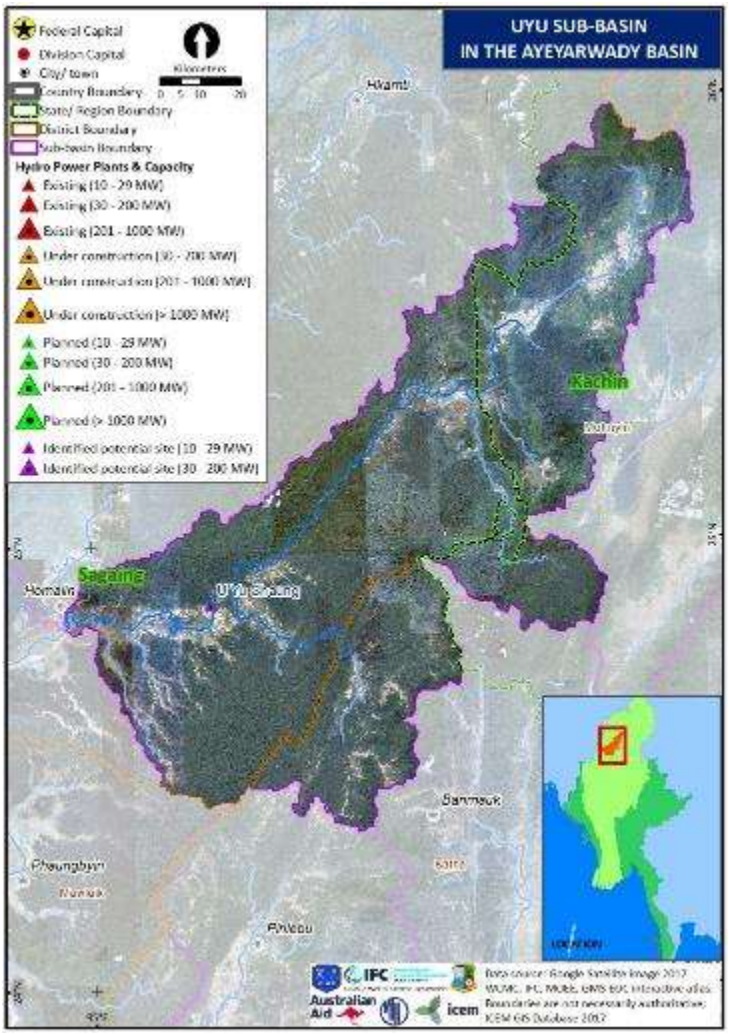
- Armed group presence: none or low
- Est. battle deaths (1989-2015) = 1
- Media-reported armed conflict incidents (2012-2016) = 0
- Historical conflict-related displaced people (est.) = 0

4.2.6 Uyu

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
3	1	4	2	3

Overview



Sub-basin size = medium

Location = Kachin state, northern Myanmar

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	78%
Slopes<3 Elev>30m	18%
Slopes>10 intermed rock	4%

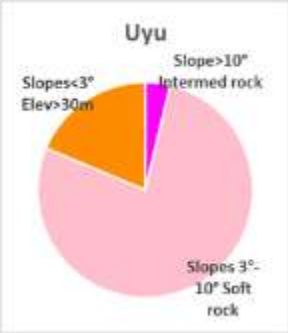
Physical	Area: 11,440 km^2 Average rainfall: 2,187 mm Average sub-basin outflow: 699.1 m^3/s
Socio-economic	Population: 370,874 Ethnic diversity: Kachins (Singpho), Lisu, Nagss (Ao, Sma, Lhota, Rengma, etc.) Economic activities: + Mining area: 317.3 km^2 (covers 2.77% of sub-basin) + Navigable waterways: None + Land use: Plantation (0%), Agriculture-Rainfed-Single (3.5%), Flood Plain-Double (0.1%), Irrigated-Single (0.1%), Irrigated-Double (0.6%), Irrigated-Triple (0.1%)

Administration	States/Regions: Kachin and Sagaing Major town/s: Hpakan
Hydropower development	Existing: 0 Under construction: 0 Planned: 0 Identified potential site: 1 (U Yu Chaung – 12 MW)

Geomorphology and sediment	Rating	3

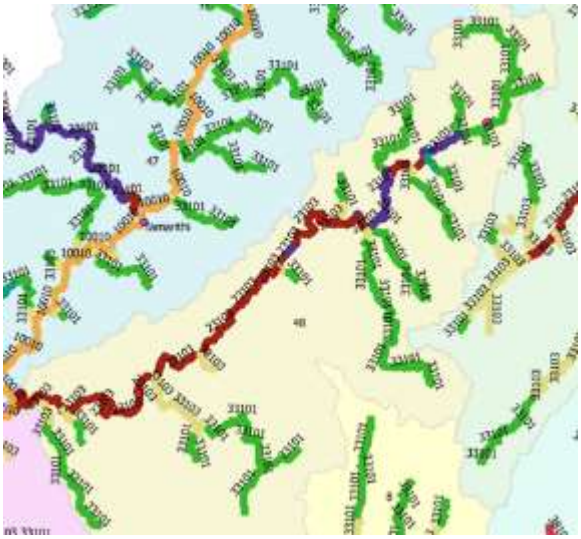
Sub-basin size: large (60th percentile; Strahler Order 3)

- A relatively flat catchment with no existing HPPs drains the eastern side of the Upper Ayeyarwady, resulting in a high connectivity score.
- The sub-basin originally has a low sediment input score, but mining activity has disturbed large areas of the catchment and the natural conditions have been greatly altered.
- This catchment has a geomorphology rating of 3 because land use is not considered, but the extensive mining and disturbance should be recognized and a rating of 2 is probably more appropriate.

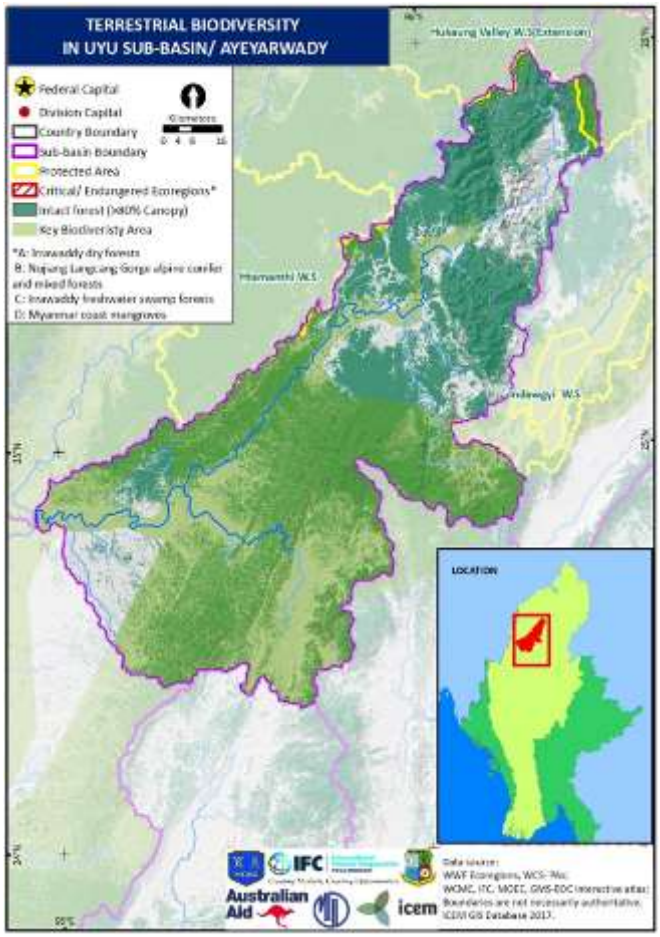


Aquatic ecology and fisheries	Ecological value rating	1
	Human pressure rating	2

- A major tributary of the Chindwin flowing in from the northeast; it has five river reach types, two of which are rare, making up only 7% of total reach lengths. The predominant type is large river in moist broadleaf forest region at low elevation, with floodplains. The upper reaches are characterized as medium rivers in moist broadleaf forest region at low elevation, with low gradient.
- The mean annual flow is 697 m^3/sec, with a minimum flow of 31.8 m^3/sec, showing a much wider variability than many of the other rivers. The ratio of its mean annual flow/minimum flow is about 20 compared to 10 in other rivers.
- While not noted for endemic or threatened species, the Uyu River was originally identified as a KBA because of water birds. However, intensive alluvial gold mining activity in the floodplains has destroyed much of the aquatic habitat and contaminated the waters with high sediments and mining waste. The river health is now considered very low.



Terrestrial biodiversity	Rating	4



Intact forest cover = 59%

KBA = 60%; a habitat for several mammals including gibbons, serows, tigers, and elephants.

Protected areas = 1% including the Indawgyi, the Hukaung Valley, and the Htamanthi wildlife sanctuaries

Social, livelihoods, and significant sites	Rating	2

- "Own account workers" (livelihood dependent on agriculture/NR) = 23% of the workforce
- Female-headed households = 25% of total households on average
- Avg. % of households owning a TV = 57%
- Ethnic minority groups = Kachins (Singpho), Lahu, Lisu, Nagas (Ao, Sema, Lhota, Rengma, etc.), and Shan
- Sub-basin vulnerability rating = 2

Conflict	Rating	3

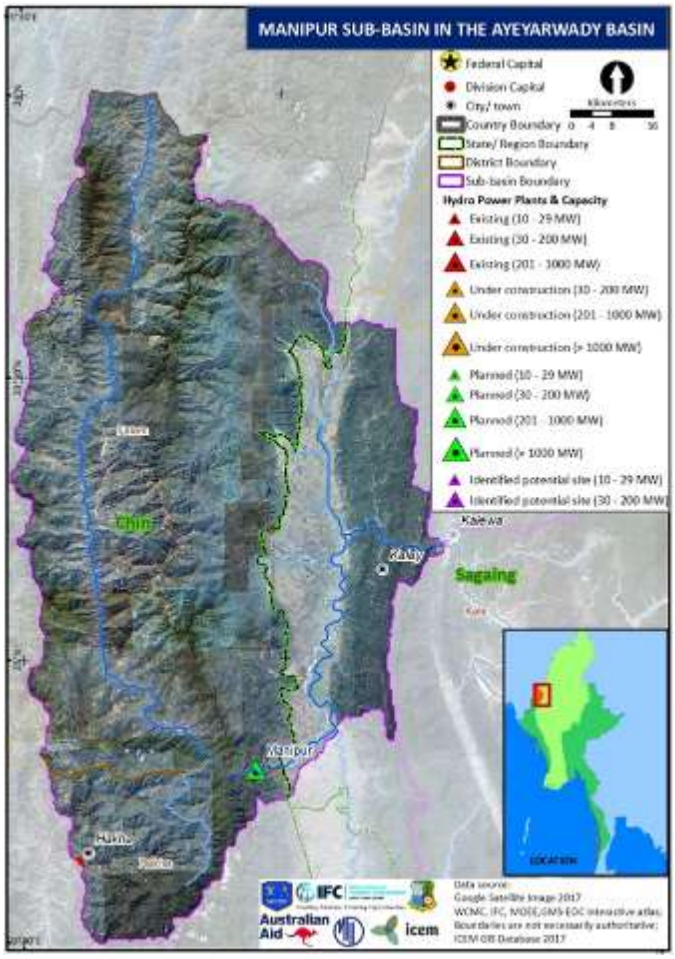
- Armed group presence: Small areas influenced by KIO
- Est. battle deaths (1989-2015) = 15
- Media-reported armed conflict incidents (2012-2016) = 34
- Historical conflict-related displaced people (est.) = 1,415
- The very high level of recent conflict suggests that the sub-basin's vulnerability may be underestimated.

4.2.7 Manipur

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
4	4	2	2	2

Overview



Sub-basin size = medium

Location = Chin State, western Myanmar

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	14%
Slopes<3 Elev>30m	3%
Slopes>10 intermed rock	83%

Physical	Area: 8,972 km^2 Average rainfall: 1,803 mm Average sub-basin outflow: 208.6 m^3/s
Socio-economic	Population: 516,151 Ethnic diversity: Chini Economic activities: + Mining area: 6.9 km^2 (covers 0.08 % of sub-basin) + Land use: Plantation (0.2%), Agriculture-Rainfed-Single (5.3%), Irrigated -Double (2.7%)
Administration	States/Regions: Chin and Sagaing Major town/s: Hakha and Kalay

Hydropower development	Existing: 0 Under construction: 0 Planned: 1 (Manipur – 380 MW) Identified potential site: 0

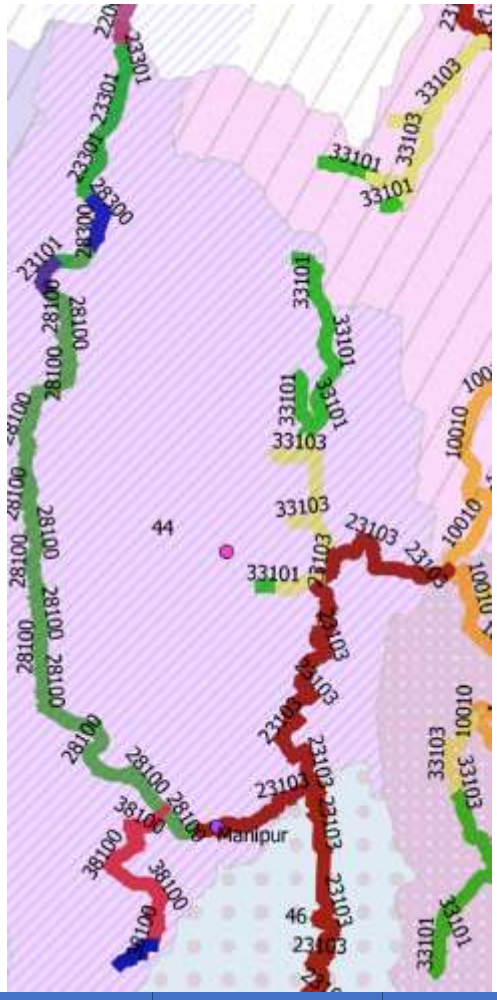
Geomorphology and sediment	Rating	4

Sub-basin size: medium (51st percentile; Strahler Order 4)

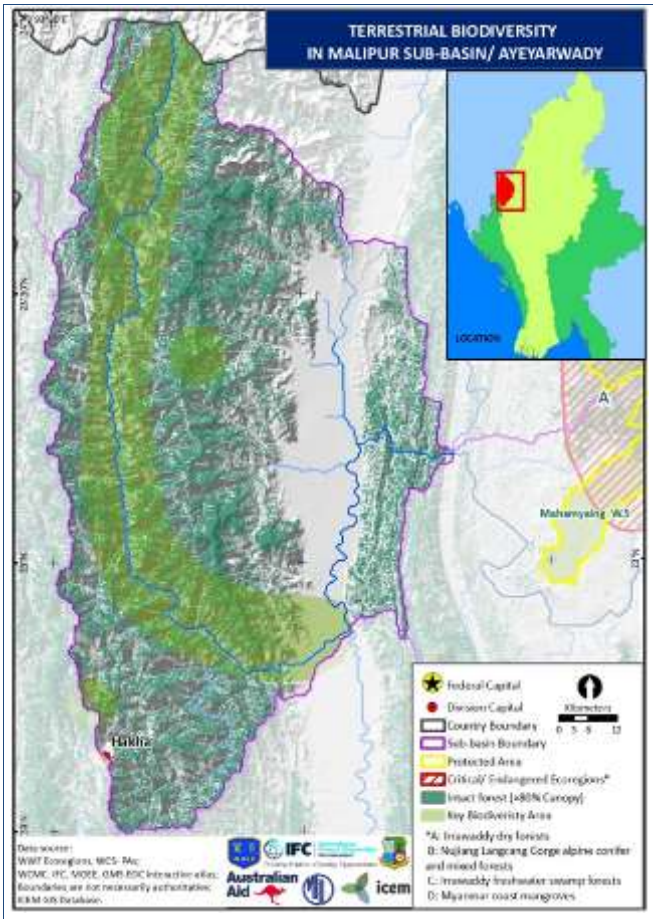
- Located in the western ranges underlain by erodible rock with high rainfall; the mainstem tributary has a Strahler Order of 4, one of a few tributaries in Myanmar with this characteristic.
- The Manipur is situated downstream of the Myittha sub-basin, which contains one HPP. When the two are considered together, the catchment area upstream of the hydropower plant is only about 10% and is unlikely to exert a strong influence on the Manipur.
- The high Strahler Order, high flow, and high sediment input result in a geomorphology rating of 4.

Aquatic ecology and fisheries	Ecological value rating	4
	Human pressure rating	4

- Flowing in from the Indian state of the same name, the river takes an eastward turn and then flows northwards again until it joins the Chindwin mainstem at Kalewa.
- Contains 12 different river reach types, seven of which are rare, making up 23% of the reach lengths. About 39% of the river reaches (in the upper and north-south parts) flow through karst limestone, while the lower reaches before meeting the Chindwin are generally large river in moist broadleaf forest region at low elevation, with floodplains.
- The mean annual flows at the confluence with the Chindwin are 782 m^3/sec, with a minimum flow of 88 m^3/sec.
- The upper river is recognized as a new riverine KBA and the sub-basin is also recognized for endemic and threatened fish species as well as other aquatic organisms.
- Human pressures include the regulation and potential pollution from India with its high population, intensive agriculture, and a hydropower plant.
- In Myanmar, the upper reaches generally have good forest cover and low agriculture intensity. Agricultural and mining activities increase in the lower valley. Kale is a large town posing some industrial pollution on the river.
- The proposed Manipur HPP would be located above where the river flows out of the limestone hills into its floodplain and turns northwards.



Terrestrial biodiversity	Rating	2



Intact forest cover = 34%

KBA = 29%, with endemic fish species threatened by potential HPPs likely to disrupt natural breeding and migration patterns

Social, livelihoods, and significant sites	Rating	2

- "Own account workers" (livelihood dependent on agriculture/NR) = 16% of the workforce
- Female-headed households = 25% of total households on average
- Avg. % of households owning a TV = 36%
- Ethnic minority groups = Chini
- Sub-basin vulnerability rating = 2

Conflict	Rating	2

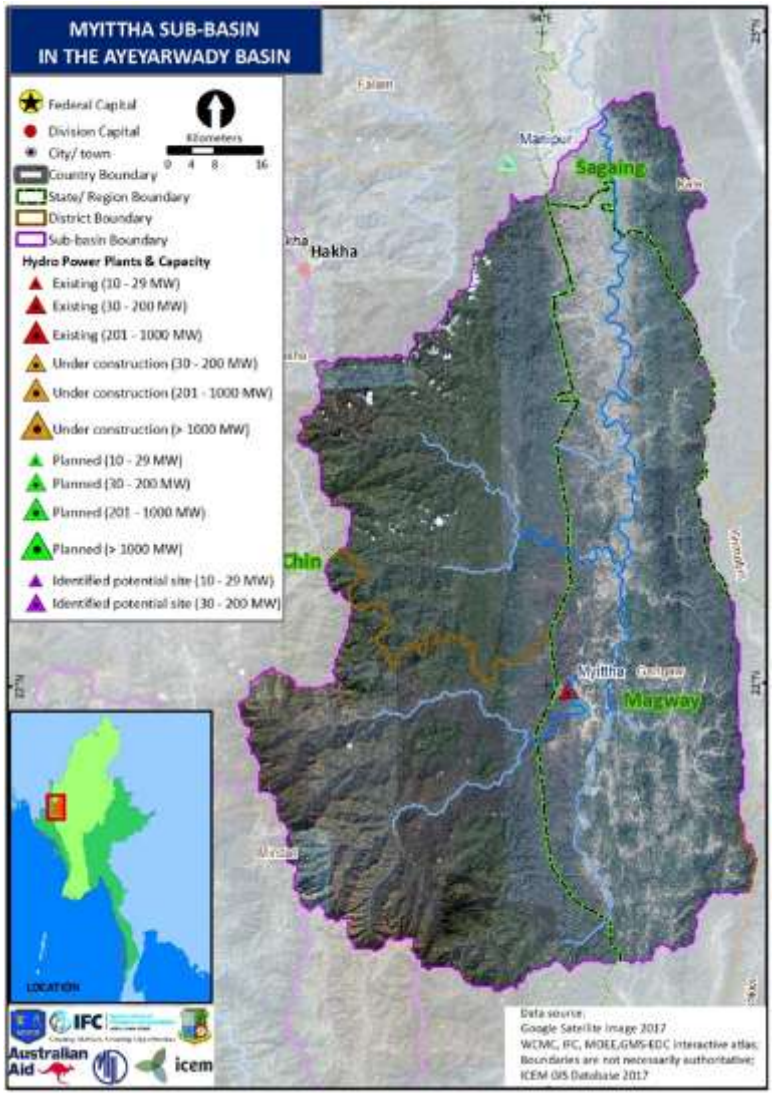
- Armed group presence: The Chin National Front (CNF) ceasefire, active in <50% of the sub-basin
- Est. battle deaths (1989-2015) = 5
- Media-reported armed conflict incidents (2012-2016) = 1
- Historical conflict-related displaced people (est.) = 0

4.2.8 Myittha

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
2	1	2	2	1

Overview



Sub-basin size = medium

Location = Chin state, western Myanmar

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	56%
Slopes<3 Elev>30m	2%
Slopes>10 intermed rock	42%

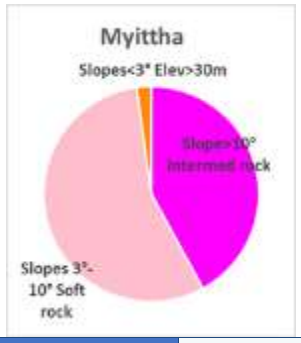
Physical	Area: 8,644 km^2 Average rainfall: 1,542 mm Average sub-basin outflow: 208.6 m^3/s
Socio-economic	Population: 230,513 Ethnic diversity: Chini Economic activities: + Mining area: 11.6 km^2 (covers 0.13% of sub-basin) + Navigable waterways: None +Land use: Plantation (0%), Agriculture-Rainfed-Single (12%), Irrigated-Double (1.2%)

Administration	States/Regions: Chin, Magway, and Sagaing Major town/s: Gangaw and Tilin
Hydropower development	Existing: 1 (Myittha – 40 MW) Under construction: 0 Planned: 0 Identified potential site: 0

Geomorphology and sediment	Rating	2

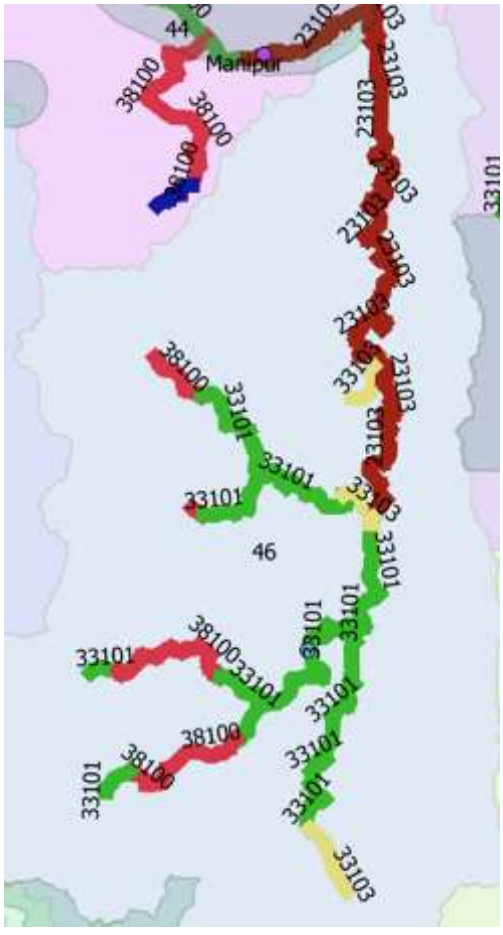
Sub-basin size: medium (47th percentile; Strahler Order 3 river)

- Situated in the Western Ranges and drains both steep and shallow sloping areas of erodible strada.
- A newly commissioned HPP in the catchment has a large reservoir and regulates around 20% of the sub-basin area, suggesting it has the potential to alter flow regimes on scales of weeks to months.
- The overall geomorphology rating is 2 but is very close to the cut off for 3.

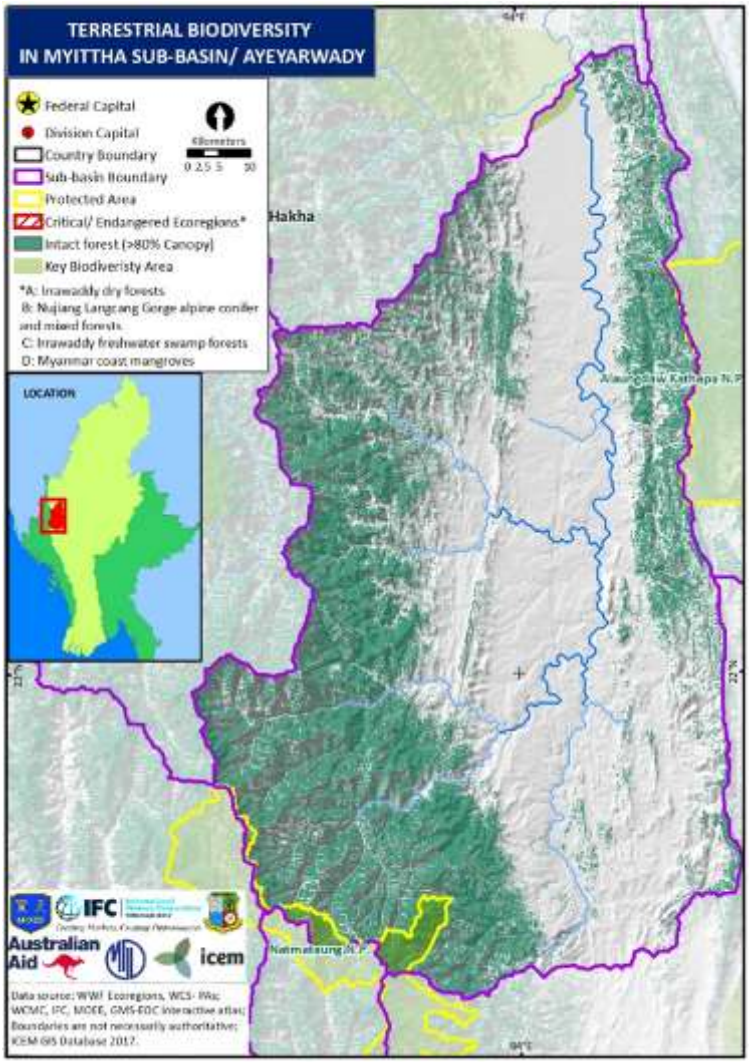


Aquatic ecology and fisheries	Ecological value rating	1
	Human pressure rating	2

- A relatively small sub-basin that flows from south to north to join the Manipur River. It has four river reach types, none of which are rare and predominated by the common large river in moist broadleaf forest region at low elevation, with floodplains. In the upper reaches, it has medium river in moist broadleaf forest region at low elevation, with low gradient and with floodplains. Karst river reaches make up about 15% of the reach lengths.
- The mean annual flow is estimated at 207 m^3/sec with a minimum flow of 20 m^3/sec.
- Not an area of endemic or threatened fish species and no aquatic KBAs.
- Human pressures are generally low despite moderate mining activity. Agricultural activities are restricted to the lowland river valley and floodplains.
- The Myittha HPP has been constructed recently with a relatively low impact on the aquatic ecology. The 12 km^2 reservoir is small but has a 45-day retention time and a high degree of regulation at the dam site. Since the flow is small, this degree of regulation is minimized by the confluence with the Manipur River.



Terrestrial biodiversity	Rating	2



Intact forest cover = 31%

KBA = 2%

Protected areas = 1.5%; the Alaungdaw Kathapa and Matmataung national parks, which house several mammal species including elephants, tigers, leopards, and bears

Social, livelihoods, and significant sites	Rating	2

- "Own account workers" (livelihood dependent on agriculture/NR) = 22% of the workforce
- Female-headed households = 24% of total households on average
- Avg. % of households owning a TV = 42%
- Ethnic minority groups = Chini
- Sub-basin vulnerability rating = 2

Conflict	Rating	1

- Armed group presence: None or low
- Est. battle deaths (1989-2015) = 0
- Media-reported armed conflict incidents (2012-2016) = 0
- Historical conflict-related displaced people (est.) = 0

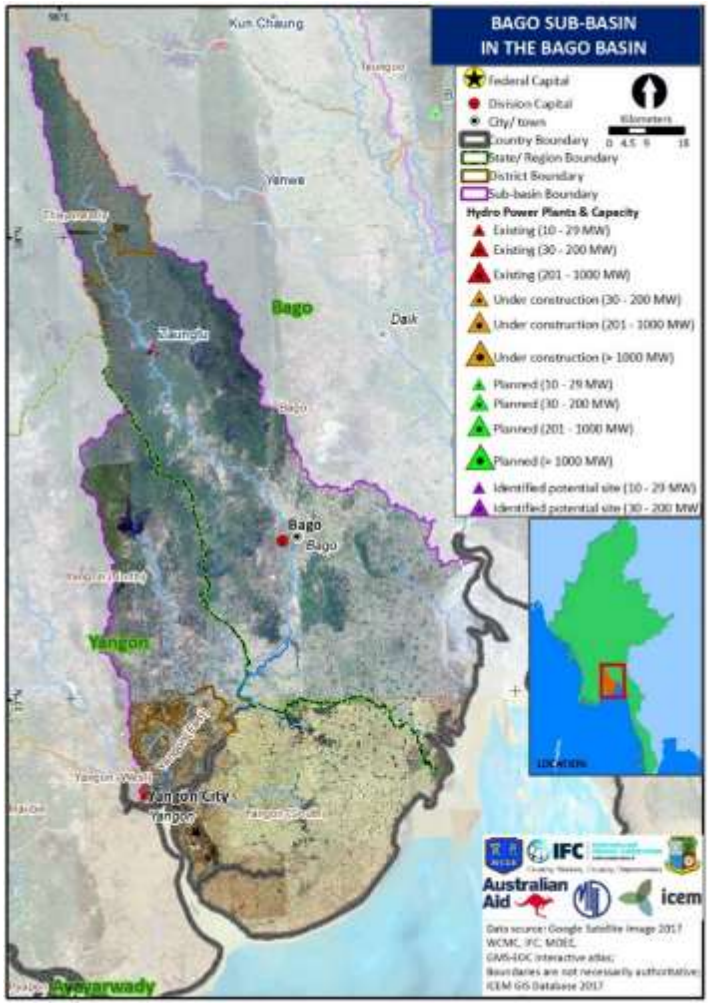
4.3 Bago and Myit Mo Hka Basin

4.3.1 Bago

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
2	1	2	1	1

Overview



Sub-basin size = small

Location = Coastal sub-basin in southern Myanmar, draining directly into the Andaman Sea; covers most of Yangon

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	15%
Slopes<3 Elev<30m	64%
Slopes<3 Elev>30m	21%

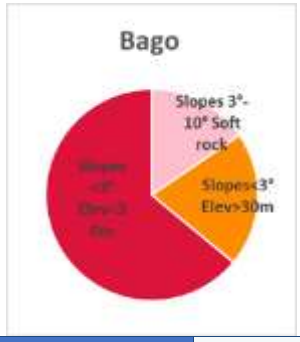
Physical	Area: 10,261 km^2 Average rainfall: 3,151 mm Average sub-basin outflow: 328.4 m^3/s
Socio-economic	Population: 4,610,213 Ethnic diversity: Karen Economic activities: + Mining area: 0.1 km^2 + Navigable waterways: None + Land Use: Plantation (0.1%), Agriculture-Rainfed-Single (3.2%), Flood Plain-Single (0.4%), Irrigated-Single (14.3%), Irrigated-Double (12.8%), Irrigated-Triple (15.3%)

Administration	States/Regions: Bago and Yangon Major town/s: Bago, Dagon Myothit (East), Dagon Myothit (North), Dagon Myothit (Seikkan), Dagon Myothit (South), Dawbon, Hlegu, Htaukkyant, Kawa, Kayan, Kyauktan, Mingalartaungnyunt, North Okkalapa, Pazundaung, South Okkalapa, Tadar, Tamwe, Thaketa, Thanatpin, Thanlyin, Thingangyun, and Thongwa
Hydropower development	Existing: 1 (Zangtu) Under construction: 0 Planned: 0 Identified potential site: 0

Geomorphology and sediment	Rating	2

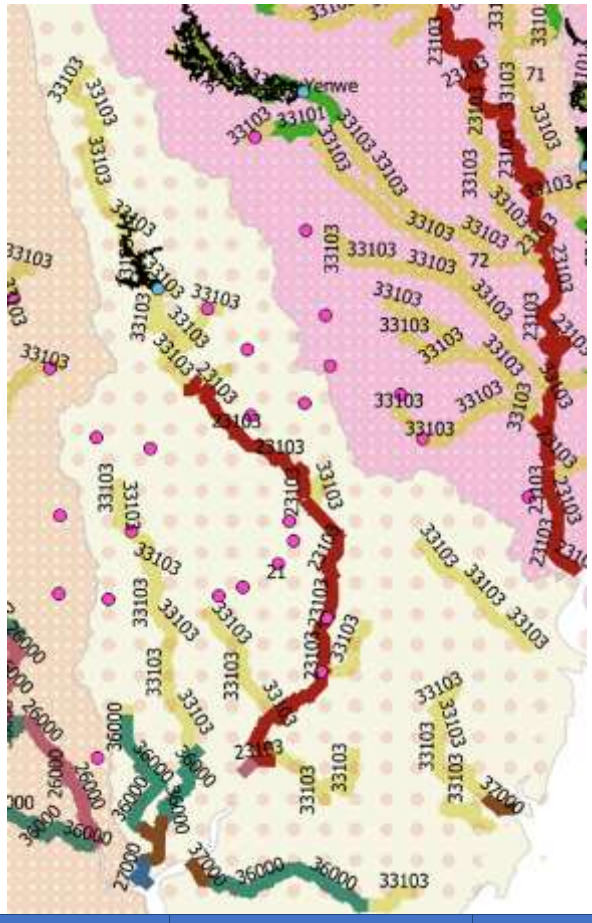
Sub-basin size: medium (58th percentile)

- Drains the southern Bago Hills and flows directly to the sea via a broad floodplain and delta.
- One multi-use HPP with a large retention capacity and the potential to alter flows monthly or seasonally.
- The small sub-basin area, low Strahler Order (2), and regulated flow result in a relatively low geomorphic rating.
- Despite this rating, rivers flowing directly into the sea have an important geomorphic function in maintaining coastlines and deltas.

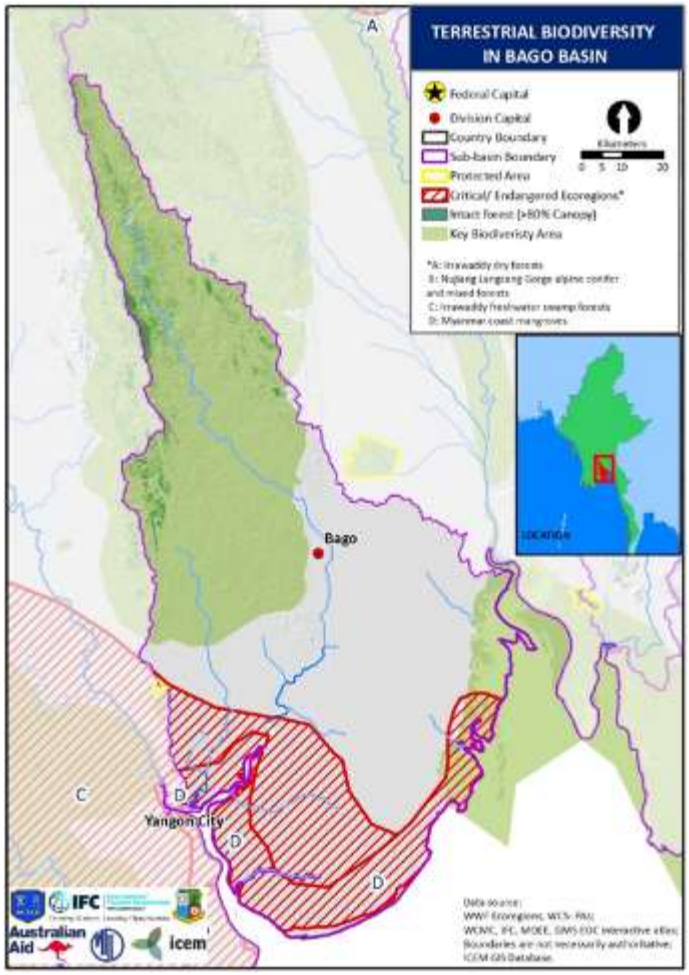


Aquatic ecology and fisheries	Ecological value rating	1
	Human pressure rating	4

- Contains six river reach types, including four rare types covering 23% of total reach length. Predominant types are large and medium rivers in the moist broadleaf forest region at low elevation, with floodplains. Reaches near the sea occur in large delta and mangrove areas.
- The mean annual flow down the Bago is 328 m^3/sec with a minimum flow of 25 m^3/sec.
- Endemic fish species are found in Upper Bago Yoma. The Hilsa migrate up the Bago and some threatened fish species occur there.
- Terrestrial KBAs in Central Bago Yoma and North Zarmayi Elephant Range
- Human pressures include a high population density and intensive agriculture with at least 15 irrigation reservoirs and weirs.
- The existing HPP, Zaungtu (20 MW), has a high impact on aquatic ecology, especially water quality and flows. The 18.5 km-long reservoir has a 61-day residence time and a 17% degree of regulation at the dam site.



Terrestrial biodiversity	Rating	2



Intact forest cover = 2%

KBA = 40%, home to wild elephants

Protected area = 0%

Critically endangered ecoregions = 24%; the Irrawaddy freshwater swamp forests (12%) and coast mangrove forests (12%), diminished by dredging, logging, and hunting

Social, livelihoods, and significant sites	Rating	1

- "Own account workers" (livelihood dependent on agriculture/NR) = 15% of the workforce
- Female-headed households = 26% of total households on average
- Avg. % of households owning a TV = 74%
- Ethnic minority groups = Karen
- Sub-basin vulnerability rating = 1

Conflict	Rating	1

- Armed group presence: none or low
- Est. battle deaths (1989-2015) = 23
- Media-reported armed conflict incidents (2012-2016) = 0
- Historical conflict-related displaced people (est.) = 0

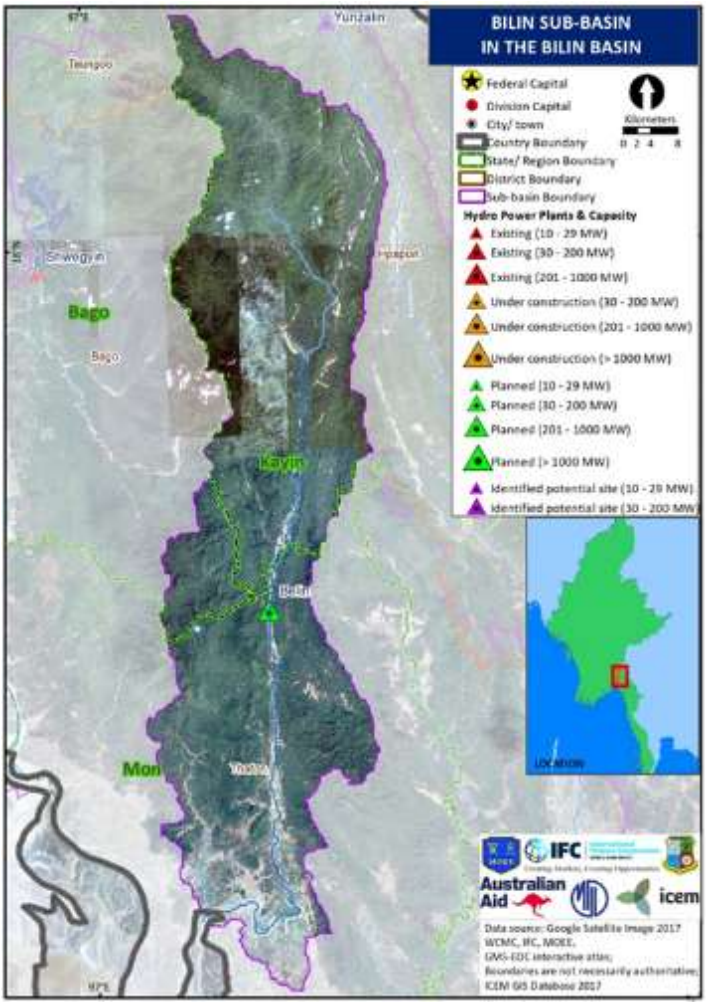
4.4 Bilin Basin

4.4.1 Bilin

Baseline value ratings

Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
2	1	2	4	3

Overview



Sub-basin size = relatively small

Location = Kayin State, eastern Myanmar

Topography:

Type	% cover of sub-basin
Slopes 3-10 soft rock	49%
Slopes<3 Elev<30m	16%
Slopes>10 hard rock	35%

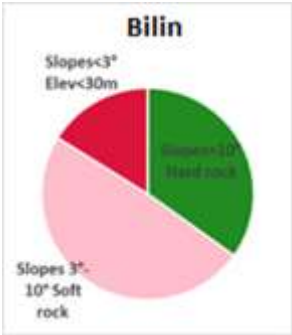
Physical	Area: 3,056 km^2 Average rainfall: 3,138 mm Average sub-basin outflow: 179m^3/s
Socio-economic	Population: 216,160 Ethnic diversity: Karen and Kayah Economic activities: + Mining area: 4 km^2 (covers 0.13% of sub-basin) + Navigable waterways: None + Land use: Plantation (0%), Agriculture-Rainfed-Single (1.1%), Irrigated-Single (1.4%), Irrigated-Double (3.4%), Irrigated-Triple (0.3%)

Administration	States/Regions: Bago, Mon, and Kayin Major town/s: Bilin
Hydropower development	Existing: 0 Under construction: 0 Planned: 1 (Bilin – 280 MW) Identified potential site: 0

Geomorphology and sediment	Rating	2

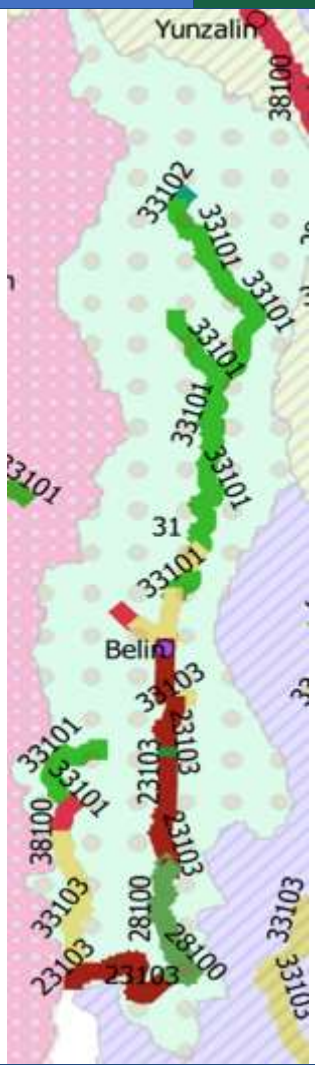
Sub-basin size: small (23rd percentile; Strahler Order 3)

- Drains the foothills of the Shan Plateau and discharges to the sea via a narrow coastal plain and delta.
- The hillsides are vegetated, but the valley floor has been highly altered through mining and agriculture; these changes would have an impact on the geomorphic processes of the sub-basin.
- No existing HPPs, high rainfall, and a river Strahler Order of 3 contribute to its final geomorphology rating.

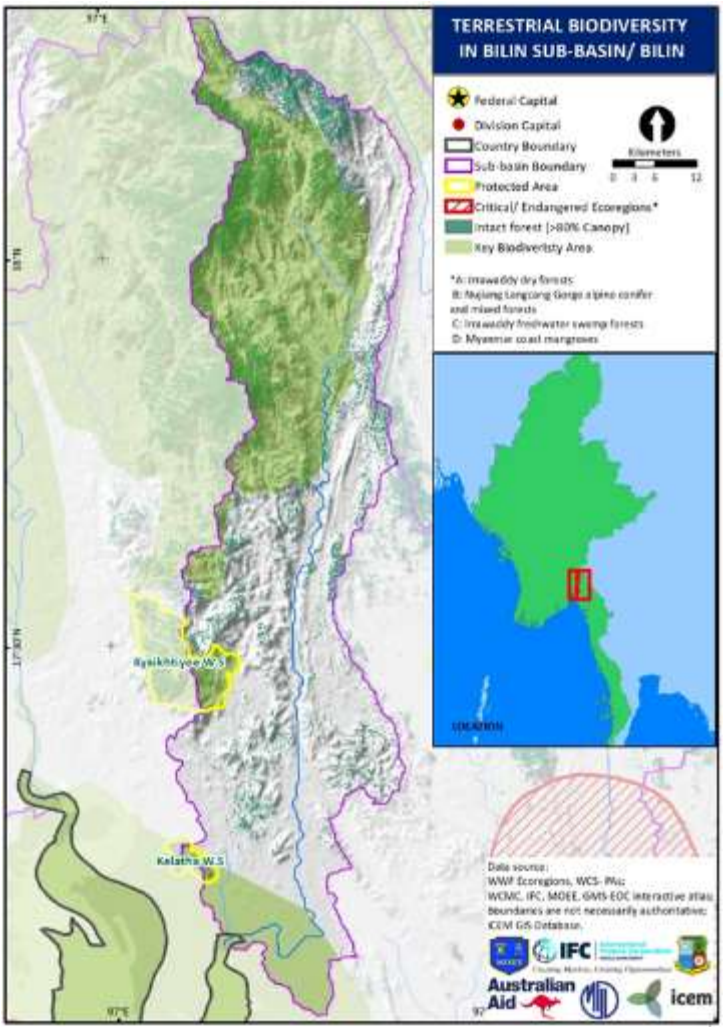


Aquatic ecology and fisheries	Ecological value rating	1
	Human pressure rating	4

- Lying between the Sittaung and the Thanlwin, the sub-basin contains seven river reach types, but only one of them is rare, covering less than 1% of the river reaches. The predominant reach types are large and medium rivers in moist broadleaf forest region at low elevation, with low gradient and floodplains; only a very small amount of karst exists in the lower end of the sub-basin.
- The mean annual flow at the mouth of the Bilin is 177 m^3/sec with a minimum flow of 9 m^3/sec.
- The river has no endemic species but discharges into the Gulf of Mottama, a very productive and diverse coastal ecosystem with important water birds (a potential Ramsar site).
- Human pressures include high population density, mining, and intensive agriculture.
- One HPP is proposed for Bilin.



Terrestrial biodiversity	Rating	2



Intact forest cover = 15%

KBA = >40%; a diverse range of species including elephants, tigers, endemic fish, tortoises, and more

Protected area = 2%; the Kelatha and Kyaikhtiyoe wildlife sanctuaries for several bird species

Critically endangered ecoregions = 0%

Social, livelihoods, and significant sites	Rating	4

- "Own account workers" (livelihood dependent on agriculture/NR) = 17% of the workforce
- Female-headed households = 32% of total households on average
- Avg. % of households owning a TV = 39%
- Ethnic minority groups = Karen and Kayah
- Sub-basin vulnerability rating = 4

Conflict	Rating	3

- Armed group presence: tolerated in some of the sub-basin, Karen National Union (KNU) ceasefire
- Est. battle deaths (1989-2015) = 17
- Media-reported armed conflict incidents (2012-2016) = 0
- Historical conflict-related displaced people (est.) = 10,933

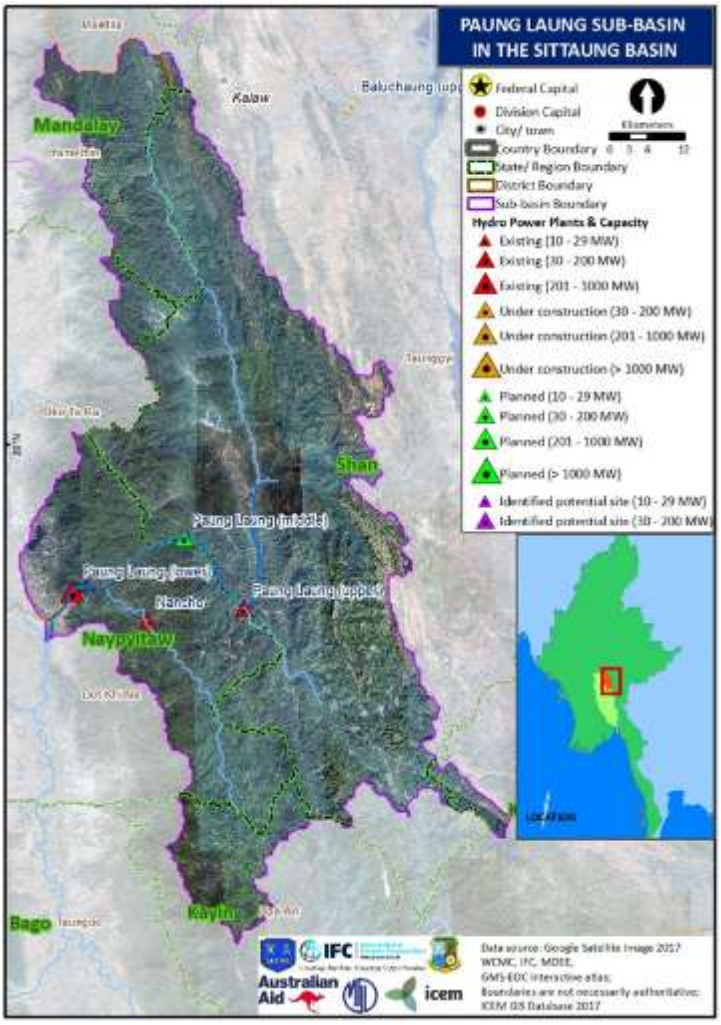
4.5 Sittaung Basin

4.5.1 Paung Laung

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
2	2	3	1	2

Overview



Paung Laung is a medium-sized sub-basin that falls within the Kayah, Kayin, and Shan states in the center of Myanmar.

Area: 4,986 km^2

Average rainfall: 1,269 mm

Average sub-basin outflow: 95 m^3/s

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	4%
Slopes 3-10 soft rock	4%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	92%
Slopes>10 intermed rock	0%

Socio-economic	Population: 594,705 Ethnic diversity: Karen, Kayah, Shan Economic activities: + Mining area: 2.7 km^2 (covers 0.05% of sub-basin) + Navigable waterways: None + Land use: Plantation (0.1%); Agriculture-Rainfed-Single (1.1%), Irrigated-Single (0.3%), Irrigated-Triple (1.6%)
Administrative:	States/Regions: Kayah, Kayin, Mandalay, Nay Pyi Taw, Shan Major town/s: Zay Yar Thi Ri

Status of hydropower development	Existing: 3 (Nancho – 40 MW, Paung Laung (lower) – 280 MW, Paung Laung (upper) – 140 MW) Under Construction: 0 Planned: 1 (Paung Laung (middle) – 100 MW) Identified potential site: 0

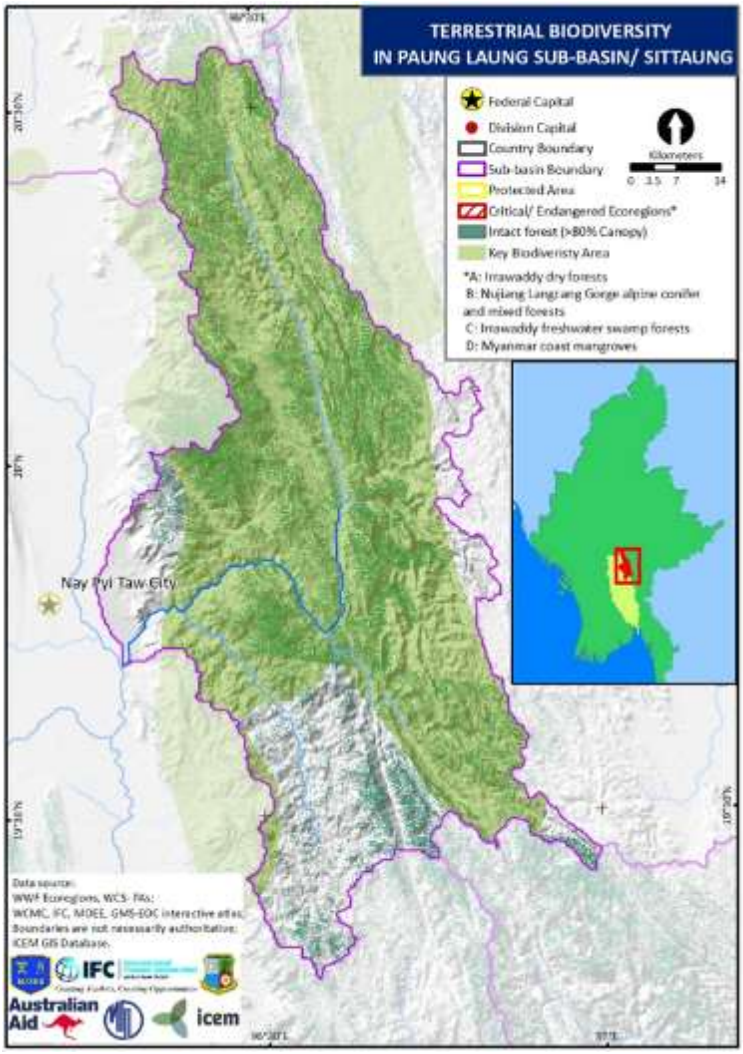
Geomorphology and sediment	Rating	2

- The small (32nd) Paung Laung sub-basin is a tributary of the Sittuang with its catchment extending up the western side of the Shan Plateau;
- It receives high rainfall and has the potential for high sediment input, but the sub-basin has been developed for hydropower;
- The hydropower development results in the regulation of flow from over 90% of the sub-basin, with two of the schemes having large impoundments with long potential residence times (~30 days) that could significantly alter the flow regime of the sub-basin;
- These factors result in a low geomorphology rating.

Aquatic ecology and fisheries	Ecological Value rating	2
	Human Pressure rating	3

- The Paunglaung sub-basin lies in the headwaters of the Sittaung basin. It contains 3 river reach types, of which 1 is rare. The predominant river reach types are Medium river, in moist broadleaf forest region at low elevation, with low gradient and with floodplains. There is no karst in the medium sized river reaches, but there is karst limestone in the headwaters of the Paunlaung, including a long underground river in the hills to the east.
- The mean annual flow from the sub-basin contributing to the Sittaung is 95 m^3/sec with a minimum flow of 18 m^3/sec.
- This part of the Sittaung basin has recorded a high diversity of molluscs, and the Paunlaung catchment KBA is important for limestone caves and invertebrates.
- The main pressures on the Paunlaung sub-basin are the three existing hydropower projects Paunlaung Upper, Paunlaung Lower and Nancho. The Upper Paunlaung HPP (140 MW) has a high impact upon aquatic ecology, with a reservoir of 50 km, 121 days storage time and a 46 % degree of regulation at the dam site. Lower Paunlaung HPP (280 MW) with a 16-km reservoir and 32-day storage time, and 12% degree of regulation at the dam site. With large drawdowns and high proportion of dead storage, they both carry higher risks of poor water quality. Nancho HPP is on a smaller branch of the Paunlaung, (40 MW) with a reservoir of 3 km and only 2 days storage.

Terrestrial Biodiversity	Rating	3



The Paung Laung sub-basin contains significant regions of KBA (74%) and modest intact forest (21%) cover. The KBA in the sub-basin is a habitat for pangolins and other small mammals along with bird species such as the green peafowl.

Social, livelihoods, and significant sites	Rating	1

In the Paung Laung sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 26% of the workforce. Female-headed households, which indicate social vulnerability accounts for 18% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 58%. The ethnic minority groups in the sub-basin are Karen, Kayah and Shan. On this basis, the sub-basin vulnerability rating is 1.

Conflict	Rating	2

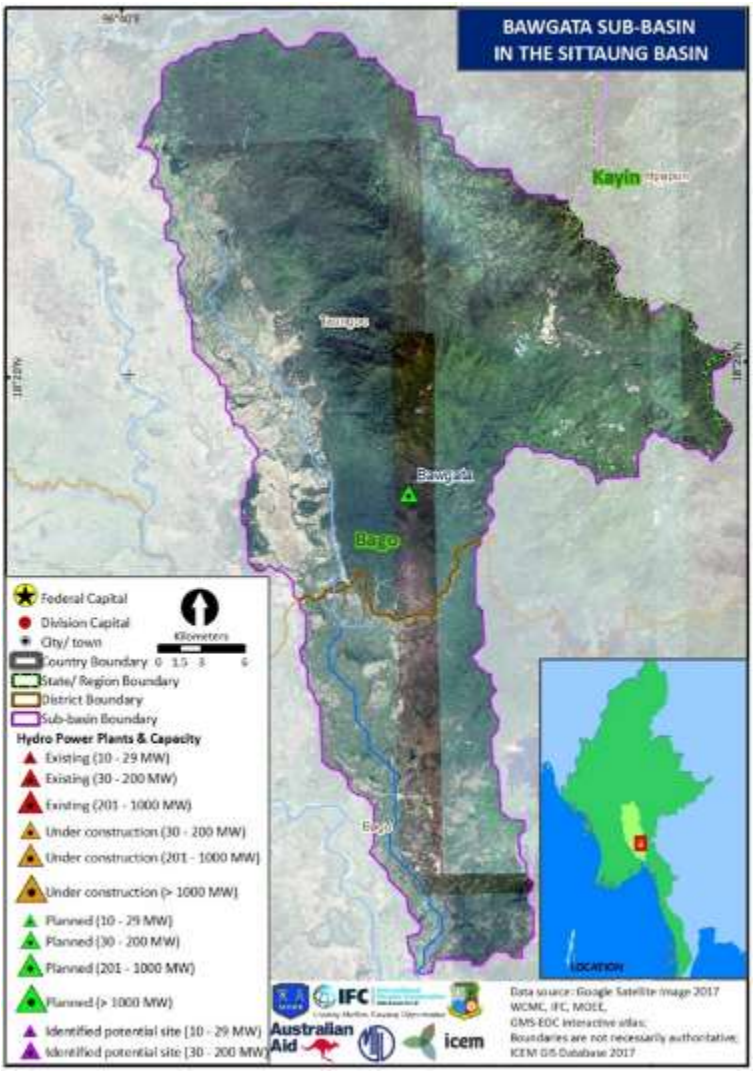
- Non- ceasefire armed group (KNPP) and Pa-O SAZ in half of sub-basin (medium)
- Zero estimated battle deaths 1989-2015 (very low)
- Zero 2012-2016 media-reported armed conflict incidents (very low)
- 1744 estimated historical conflict-related displaced people (medium)

4.5.2 Bawgata

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
1	2	2	4	3

Overview



Bawgata is one of the smaller sub-basins and is located in the Bago Region in the eastern part of Myanmar.

Area: 1,229 km^2

Average rainfall: 2,806 mm

Average sub-basin outflow: 54 m^3/s

Topography:

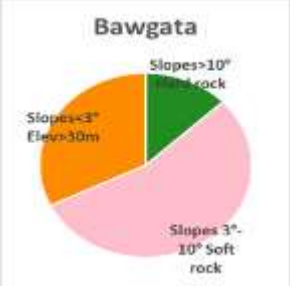
Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	55%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	32%
Slopes>10 hard rock	13%
Slopes>10 intermed rock	0%

Socio-economic	Population: 892,747 Ethnic diversity: Karen Economic activities: + Mining area: 0.02 km^2 + Navigable waterways: None + Land use: Plantation (0%); Agriculture-Rainfed-Single (6.1%), Irrigated-Single (3.0%), Irrigated – Double (1.5%), Irrigated-Triple (1.4%)
Administrative:	States/Regions: Bago State Major town/s: Kyaukkyi

Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 1 (Bawgata – 160 MW) Identified potential site: 0

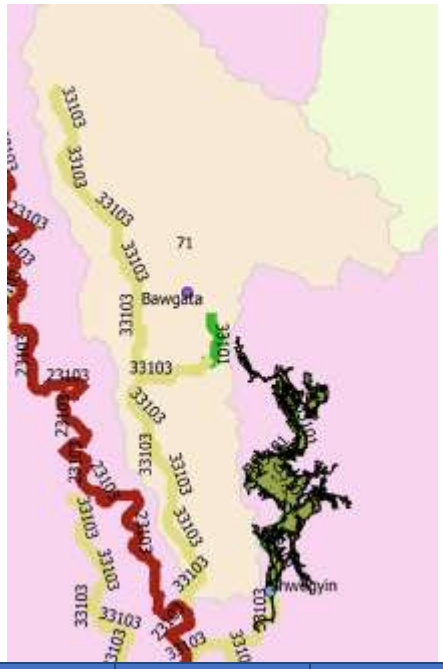
Geomorphology and sediment	Rating	1 (4)

- The very small Bawgata sub-basin (9th percentile) is a Strahler Order 2 tributary of the Sittaung River;
- The river drains the western flank of the Shan plateau before flowing through a wide alluvial plain to the confluence with the Sittuang;
- The sub-basin receives high rainfall and has a high runoff, but due to its small size, low order river and generally limited areas of sediment input, the sub-basin has a low geomorphology rating.

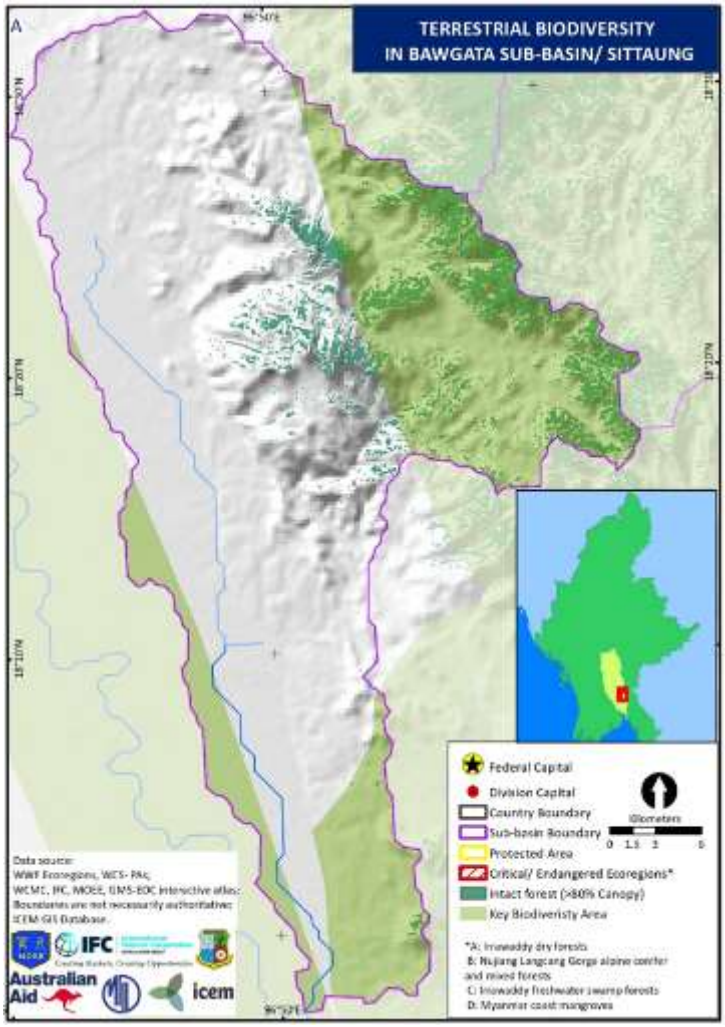


Aquatic ecology and fisheries	Ecological Value rating	2
	Human Pressure rating	2

- The Bawgata is very small tributary on the east bank of the Sittaung, just above the similarly small tributary with the Shwegyin dam. There are three river reach types, none of which are rare in this sub-basin. The predominant river reach type is Medium river, in moist broadleaf forest region at low elevation, with floodplains.
- The mean annual flows at the confluence with the Sittaung 54 m^3/sec with a minimum flow of 4.5 m^3/sec
- There are no riverine KBAs in the sub-basin, though in the southern headwaters of this sub-basin there is the terrestrial Shwe Kyin and Bawgada watershed KBA
- There are no special aquatic biodiversity features in this sub-basin
- Human pressures are generally low and the forest cover in the watershed is still good.
- A hydropower dam, Bawgata, is proposed for the sub-basin



Terrestrial Biodiversity	Rating	2



The Bawgata sub-basin does not contain any critically endangered ecoregions or protected areas. It contains relatively little intact forest (7%), but over one-third of the sub-basin is composed of KBA dedicated to a diverse range of species including elephants, tigers, endemic fish, tortoises, and more.

Social, livelihoods, and significant sites	Rating	4

In the Bawgata sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 19% of the workforce. Female-headed households, which indicate social vulnerability accounts for 34% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 31%. The ethnic minority groups in the sub-basin are Karen. On this basis, the sub-basin vulnerability rating is 4.

Conflict	Rating	3

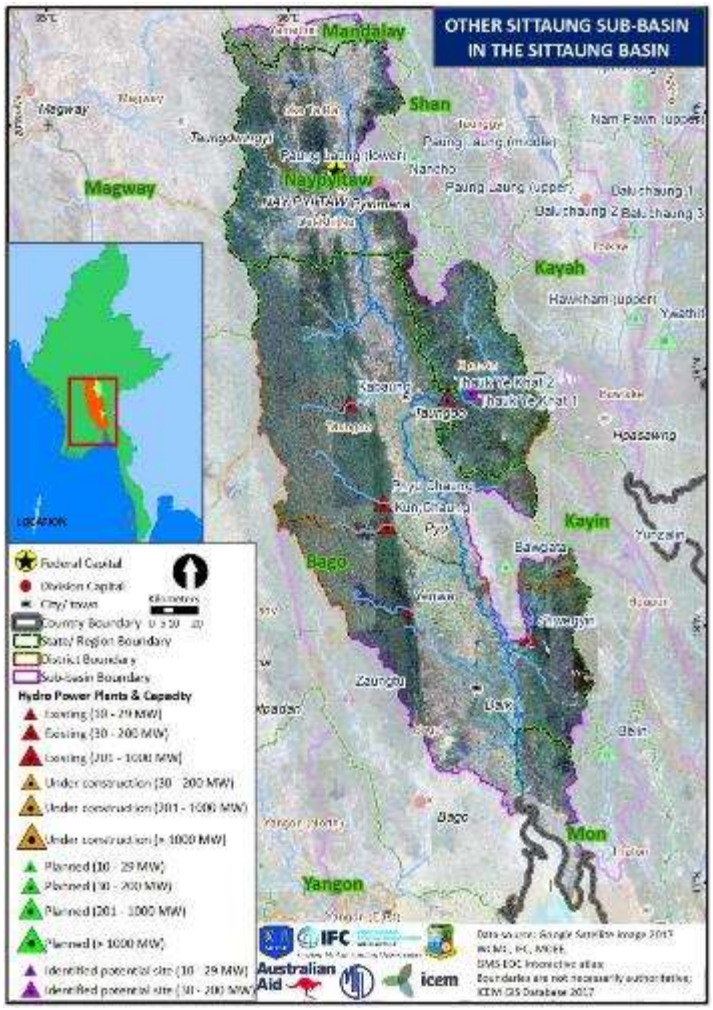
- Most of the sub-basin controlled by ceasefire armed group, KNU (medium)
- Nine estimated battle deaths 1989-2015 (very low)
- Two 2012-2016 media-reported armed conflict incidents (low)
- 16767 estimated historical conflict-related displaced people (medium)

4.5.3 Sittaung Other

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
4	2	2	1	3

Overview



Other Sittaung is the 4th largest sub-basin and spans several states in the southern region of the main body of Myanmar. It outlets to the Andaman Sea.

Area: 28,698 km^2

Average rainfall: 2,081 mm

Average sub-basin outflow: 1232.1 m^3/s

Topography:

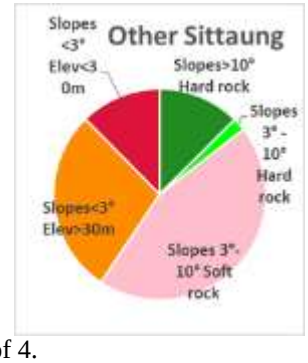
Type	% cover of sub-basin
Slopes 3-10 Hard rock	2%
Slopes 3-10 soft rock	45%
Slopes<3 Elev<30m	12%
Slopes<3 Elev>30m	28%
Slopes>10 hard rock	12%
Slopes>10 intermed rock	0%

Socio-economic	Population: 3,088,695 Ethnic diversity: Chini, Karen, Kayah Economic activities: + Mining area: 31.6 km^2 (covers 0.11% of sub-basin) + Navigable waterways: None + Land use: Plantation (0%); Agriculture-Rainfed-Single (12.4%), Flood Plain-Single (0.1%), Irrigated-Single (3.3%), Irrigated – Double (5.8%), Irrigated-Triple (5.3%)
Administrative:	States/Regions: Bago, Kayah, Kayin, Magway, Mandalay, Mon, Naypyitaw, Shan Major town/s: Daik, Lewe, NAY PYI TAW, Pyinmana, Pyu, Taungoo

Status of hydropower development	Existing: 6 (Kabaung – 30 MW, Kun Chaung – 60 MW, Phyu Chaung – 40 MW, Shwegyin – 75 MW, Thauk Ye Khat 2 – 120 MW, Yenwe – 25 MW) Under Construction: 0 Planned: 0 Identified potential site: 1 (Thauk Ye Khat 1 – 75 MW)

Geomorphology and sediment	Rating	4

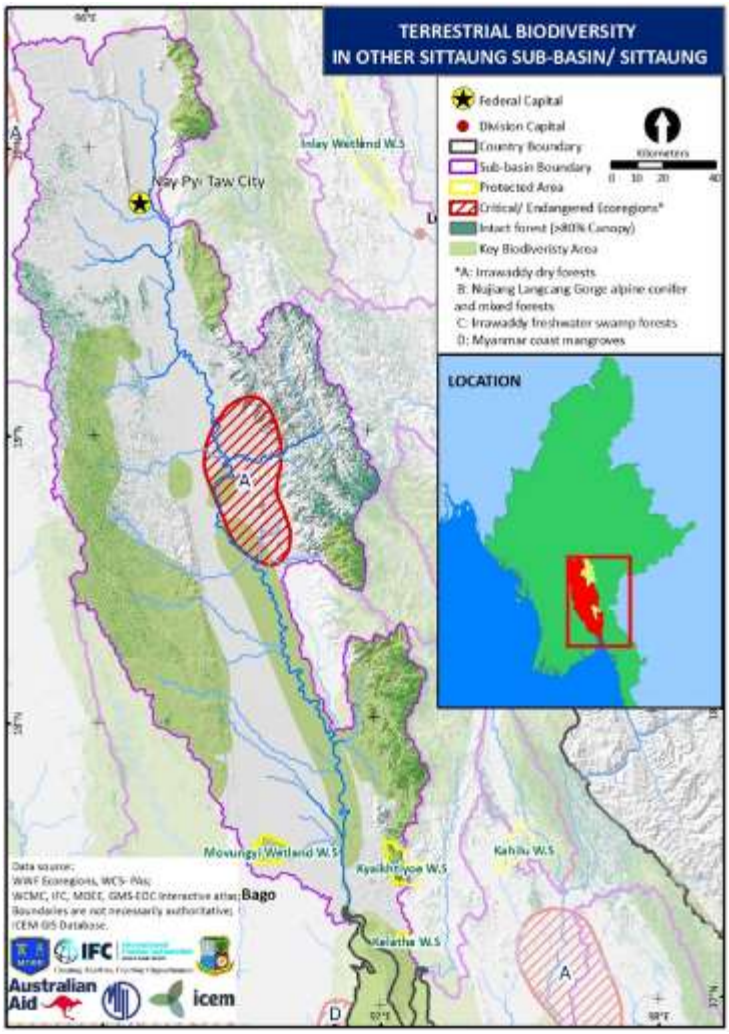
- The very large (95th percentile) Sittaung sub-basin hosts a range of land types, draining the steep, hard Shan Plateau in the east, and the lower Bagan hills in the west, with a broad alluvial valley in between;
- The sub-basin delivers water and sediment directly to the sea, maintaining the coastal fringe;
- It is modified by the presence of 6 hydropower projects on low order headwater tributaries. Collectively < 30 of the sub-basin area lies upstream of the hydropower projects;
- The hydropower projects are considered to alter the geomorphic functioning of the sub-basin to some degree, but the large water inflow, complex drainage systems and high percentage of the basin that is not regulated contribute to a high overall geomorphology rating of 4.



Aquatic ecology and fisheries	Ecological Value rating	3
	Human Pressure rating	4

- The other Sittaung sub-basin consists of the whole of the Sittaung basin, except for the Paunlaung and Bawgata sub-basins. The Sittaung river flows through a straight wide valley running from north to south between two well-forested ridges - the Bago and Paunlaung Yomas. It discharges into the sea in the Gulf of Mottama.
- The sub-basin contains 6 river reach types of which 3 are rare. The predominant river reach types are Large and medium rivers, in moist broadleaf forest region at low elevation, with floodplains and at low gradient.
- The mean annual flow of the Sittaung river at the point of discharge is 1,233 m^3/sec with a minimum flow of 141 m^3/sec
- The river contains no rare species of fish, but recent surveys indicate a high mollusc diversity and the Bago Yoma has been identified as an area where fish endemism is high.
- Several KBAs have been identified in the sub-basin, including Yay Thoe reservoir an irrigation reservoir where rare freshwater mussels have been found, a KBA along the mainstem of the Sittaung considered important for its connectivity with the Gulf of Mottama, the Central Bago Yoma, and Moyingyi wetlands, one of Myanmar's 3 Ramsar sites. These important assets raise the ecological value of the sub-basin, which would be lower as a result of the few rare river reaches
- The human pressures in the sub-basin are high due to high rural population density and the intensity of agriculture in the valleys. There are over 30 irrigation reservoirs and weirs in the sub-basin especially in the upper part of the catchment.
- In addition to 3 hydropower dams on the Paunlaung, there are 6 large hydropower projects on tributaries leading into the Sittaung – Kabaung (30 MW), Kun Chaung (60 MW), Phyu Chaung (40 MW), Shwegyin (75 MW), Thauk Ye Khat 2 (120 MW), and Yenwe (25 MW). These have had significant impact upon the aquatic ecology of the both the tributaries and of the Sittaung mainstem, especially in terms of Degree of flow regulation and risks to water quality.

Terrestrial Biodiversity	Rating	2



The Other Sittaung sub-basin contains 35% KBA and 9% intact forest. Similarly to other large sub-basins, there are numerous KBAs that provide habitats for various species of birds, mammals, and aquatic flora and fauna including the fresh water mussel and the fresh water bivalve. In the past approximately 5% of the sub-basin was composed of the critically endangered Irrawaddy dry forest ecoregion as well.

Social, livelihoods, and significant sites	Rating	1

In the Sittaung Other sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 18% of the workforce. Female-headed households, which indicate social vulnerability accounts for 24% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 45%. The ethnic minority groups in the sub-basin are Chini, Karens and Kayah. On this basis, the sub-basin vulnerability rating is 1.

Conflict	Rating	3

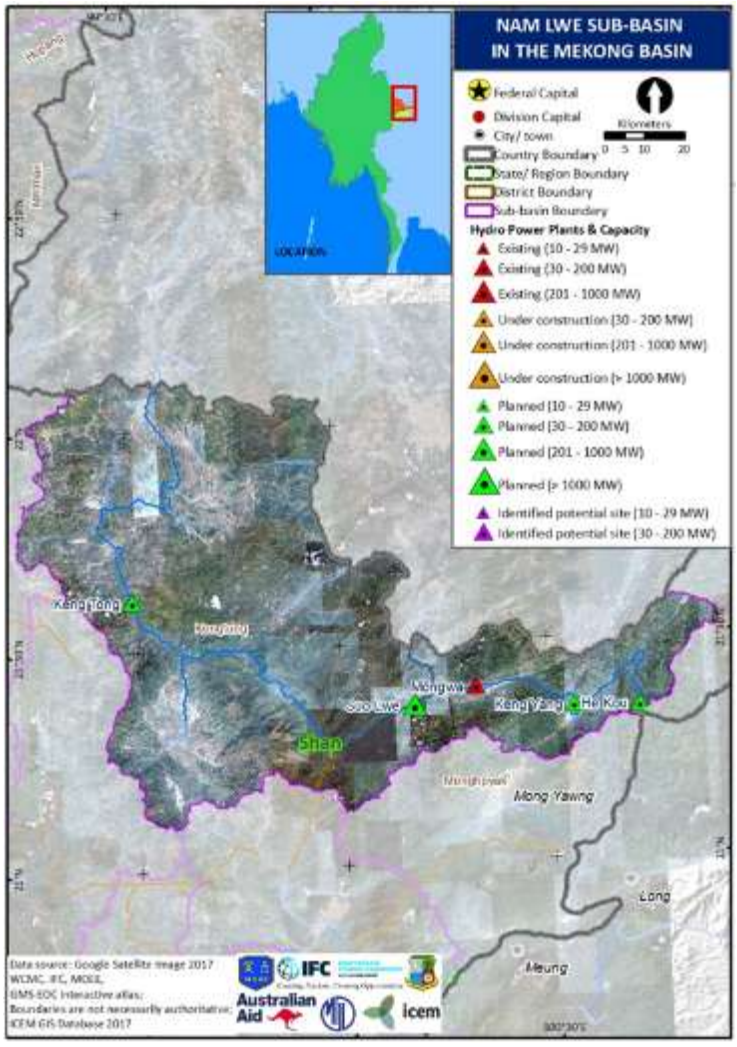
- Ceasefire armed group (KNU) influential in small parts of the sub-basin (low)
- 211 estimated battle deaths 1989-2015 (high)
- One 2012-2016 media-reported armed conflict incidents (low)
- 41628 estimated historical conflict-related displaced people (very high)

4.6 Mekong Basin

4.6.1 Nam Lwe

Baseline value ratings					
Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict	
3	2	2	1	2	

Overview



Nam Lwe is a medium-sized sub-basin located in the Shan state in the eastern part of Myanmar and shares a border with China.

Area: 9,364 km^2

Average rainfall: 1,381 mm

Average sub-basin outflow: 297.8 m^3/s

Topography:

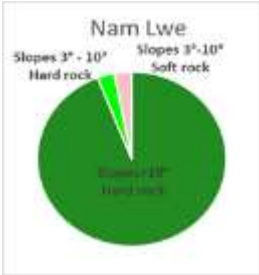
Type	% cover of sub-basin
Slopes 3-10 Hard rock	3%
Slopes 3-10 soft rock	3%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	94%
Slopes>10 intermed rock	0%

Socio-economic	Population: 366,861 Ethnic diversity: Hani (Akha, Uni, Xapho, Cosung, Cote, Khape), Kachins (Singpho), Lahu, Pulang (Puman), Shan Economic activities: + Mining area: 2.4 km^2 (covers 0.03% of sub-basin) + Navigable waterways: None + Land use: N/A
Administrative:	States/Regions: Shan Major town/s: Mong Hpen, Ho Tawng, Mong Pawk, Mong Kar, Mongkhet, Mongyang, Mongpauk, Mongla, Kengtung, Mongyu

Status of hydropower development	Existing: 1 (Mongwa – 66 MW) Under Construction: 0 Planned: 4 (He Kou – 138 MW, Keng Tong – 170 MW, Keng Yang – 70 MW, Suo Lwe – 240 MW) Identified potential site: 0

Geomorphology and sediment	Rating	3

- Nam Lwe is a medium sized sub-basin (54th percentile) in Mekong basin, with a Strahler Order 3 mainstem;
- The catchment drains steep hard rock mountains and is well vegetated with little development, except for a recently commissioned hydropower project located in the lower catchment;
- Rainfall is low compared to other parts of Myanmar, and these features combine to produce a geomorphology rating of 3, reflecting a reduction due to the loss of connectivity associated with the dam.

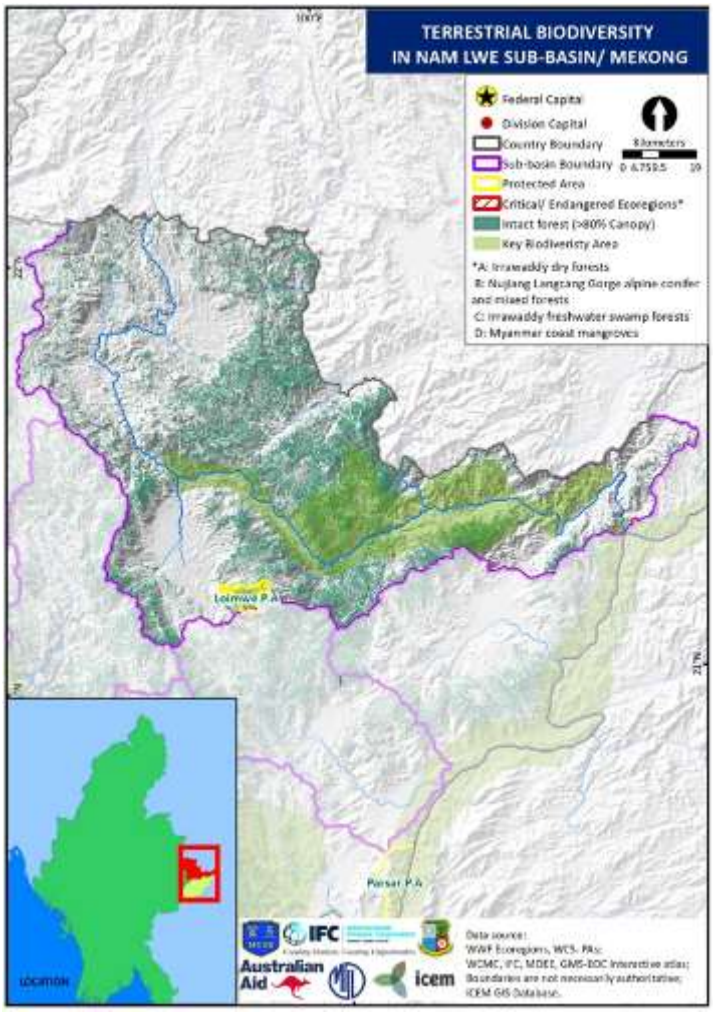


Aquatic ecology and fisheries	Ecological Value rating	2
	Human Pressure rating	3

- The Nam Lwe is the northernmost tributary of the Mekong in Myanmar, running along the Chinese border. It has 10 river reach types, 5 of which are rare covering 54% of the reach lengths in the sub-basin and 7% of reaches running through karst region. The predominant reach types are Large river, in moist broadleaf forest region at low elevation, with sediment and the rare Medium river, in moist broadleaf forest region at high elevation, with low gradient.

- The mean annual flows at the confluence with the Mekong are 297 m^3/sec with a minimum of 43 m^3/sec.
- It has some threatened fish species noted in the lower part of the sub-basin, and would be an important tributary of the Mekong for spawning fish movements and a KBA has been identified associated with this.
- Human pressures are medium, but with low population density and low agricultural intensity and mining activity. There is an existing hydropower dam Mongwa (66 MW) of relatively low impact, but blocking the fish migration route 81 km from the confluence with the Mekong.
- Four other hydropower projects are planned for the Nam Lwe - He Kou (138 MW), Keng Tong (170 MW), Keng Yang (70 MW), and Suo Lwe (240 MW).

Terrestrial Biodiversity	Rating	2



The Nam Lwe sub-basin contains modest KBA (18%) and intact forest (22%) cover. The KBA in this sub-basin is another trans-boundary corridor that supports mammal and fish migration from China. The Loimwe protected area composes around 0.5% of sub-basin area as well.

Social, livelihoods, and significant sites	Rating	1

In the Nam Lwe sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 27% of the workforce. Female-headed households, which indicate social vulnerability accounts for 12% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 54%. The ethnic minority groups in the sub-basin are Hani (Akha, Uni, Xapho, Cosung, Cote, Khape), Kachins (Singpho), Lahu, Pulang (Puman), Shan. On this basis, the sub-basin vulnerability rating is 1.

Conflict	Rating	2

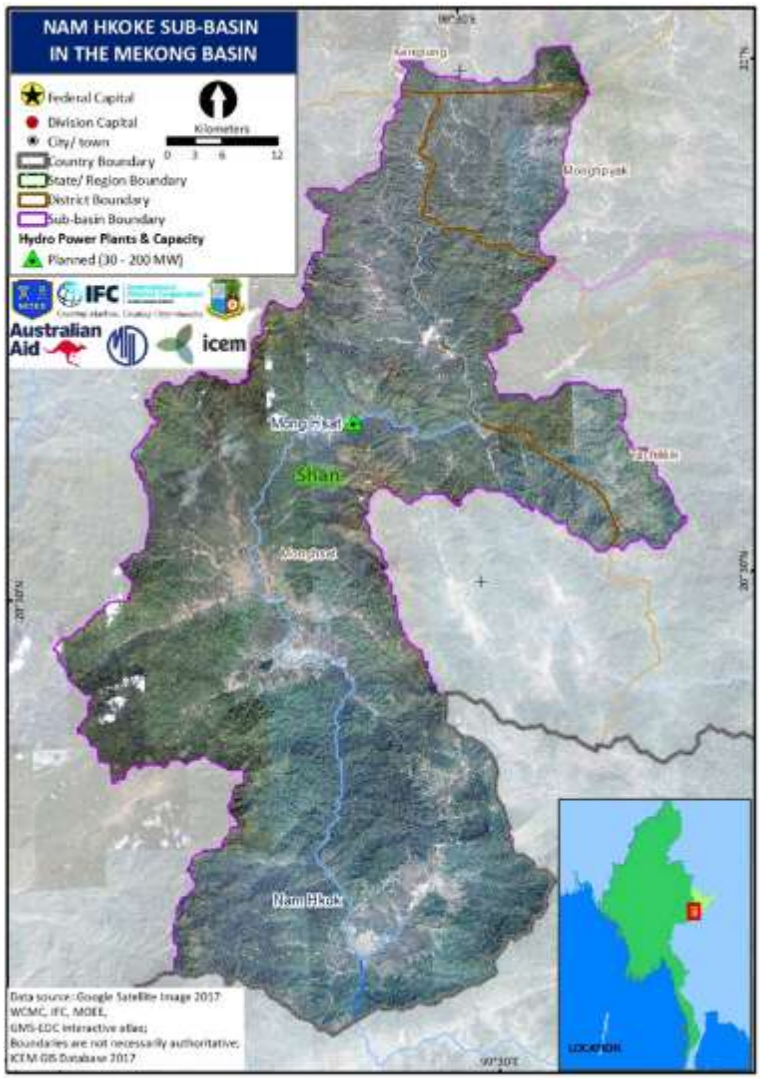
- Ceasefire armed group (RCSS) active in more than half of this sub-basin (medium)
- 12 estimated battle deaths 1989-2015 (low)
- Two 2012-2016 media-reported armed conflict incidents (medium)
- Zero estimated historical conflict-related displaced people (very low)

4.6.2 Nam Hkoke

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
2	5	2	2	3

Overview



Nam Hkoke is a relatively small sub-basin located in the Shan state in the eastern part of Myanmar and shares a border with Thailand.

Area: 3,411 km^2

Average rainfall: 1,368 mm

Average sub-basin outflow: 49.6 m^3/s

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	4%
Slopes 3-10 soft rock	4%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	92%
Slopes>10 intermed rock	0%

Socio-economic	Population: 104,649 Ethnic diversity: Kachins (Singpho), Lao, Shan, Yao Economic activities: + Mining area: No + Navigable waterways: None + Land use: N/A
Administrative:	States/Regions: Shan Major town/s: Monghsat, Mongkhoke

Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 1 (Mong Hsat – 30 MW) Identified potential site: 1 (Nam Hkok – 30 MW)

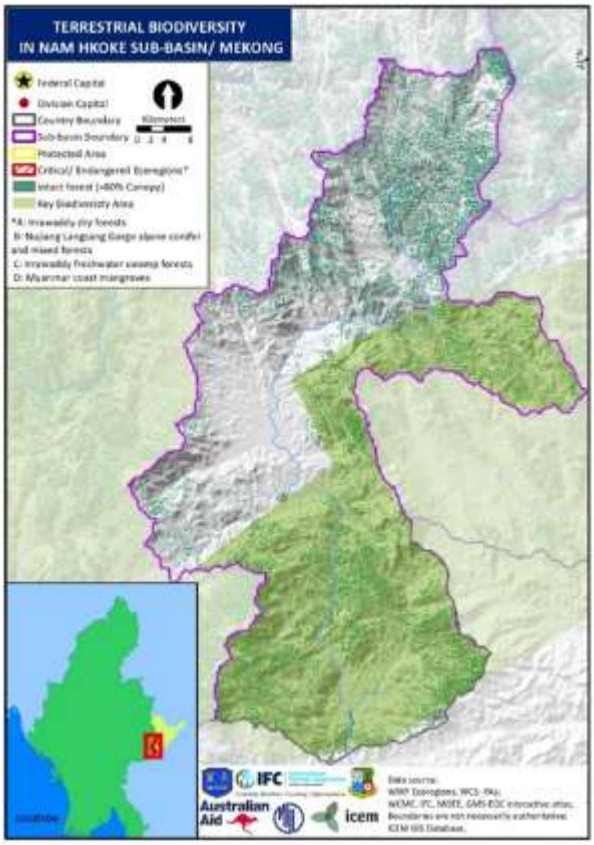
Geomorphology and sediment	Rating	2 (4)

- The Nam Hkoke sub-basin is a small (24th percentile), low order Strahler tributary of the Mekong;
- Similar to the other Mekong sub-basins it has a high potential input score sediment;
- The final rating for this sub-basin is relatively low due to its small catchment size. It has been identified as a sub-basin because it is targeted for future hydropower development

Aquatic ecology and fisheries	Ecological Value rating	5
	Human Pressure rating	1

- The Nam Hkoke sub-basin in Myanmar contains the headwaters of the Nam Mae Kok which is an important tributary of the Mekong in Thailand. It is thus a transboundary river. In Myanmar, the river consists of 128 km of medium sized river with 4 river reach types, one of which is rare, making up 26% of the reach lengths. Over 50% of the river reaches flow through a karst region at low elevation.
- The mean annual flow at the point where it crosses the border into Thailand is 50 m^3/sec with a 7.4 m^3/sec minimum flow
- The high Ecological Value rating registered is largely due to the presence of endangered fish species and critically endangered aquatic plants and insects that have been found in the Nam Mae Kok in Thailand and are assumed to occur in the Nam Hkoke in Myanmar.
- Human pressures are very low on this sub-basin, especially as it is in a border area.
- Two hydropower dams are proposed on the Nam Hkoke, the Nam Hkok (30 MW) and the Mong Hsat (30 MW).

Terrestrial Biodiversity	Rating	2



Nam Hkoke contains notable KBA (50%) and modest intact forest (19%) cover. The KBA in the sub-basin includes the Golden Triangle Area and the Namsam Mountain Region, which are habitats for aquatic plant species, vulnerable species of dragon flies, and other aquatic species such as turtles.

Social, livelihoods, and significant sites	Rating	2

In the Nam Hkoke sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 27% of the workforce. Female-headed households, which indicate social vulnerability accounts for 12% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 43%. The ethnic minority groups in the sub-basin are Karen. On this basis, the sub-basin vulnerability rating is 2.

Conflict	Rating	3

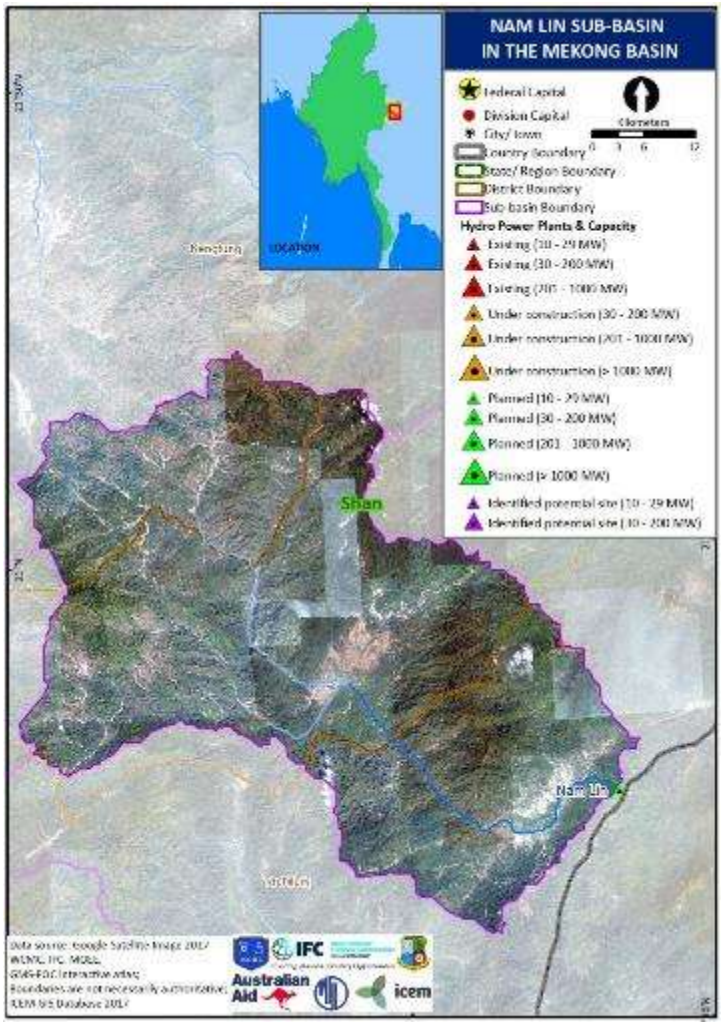
- Multiple armed groups active in much of the sub-basin, with ceasefires and closer relationships with the Myanmar army (medium)
- Nine estimated battle deaths 1989-2015 (very low)
- One 2012-2016 media-reported armed conflict incidents (low)
- 18722 estimated historical conflict-related displaced people (very high)

4.6.3 Nam Lin

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
1	2	2	1	1

Overview



Nam Lin is a small sub-basin located in the Shan state in the eastern part of Myanmar and shares a border with Laos.

Area: 2,638 km^2

Average rainfall: 1,408 mm

Average sub-basin outflow: 46.1 m^3/s

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	15%
Slopes 3-10 soft rock	15%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	70%
Slopes>10 intermed rock	0%

Socio-economic	Population: 207,869 Ethnic diversity: Hani (Akha, Uni, Xapho, Cosung, Cote, Khape), Lahu, Lao, Shan, Yao, Yuan Economic activities: + Mining area: 4.8 km^2 (covers 0.18 % of sub-basin) + Navigable waterways: None + Land use: N/A
Administrative:	States/Regions: Shan Major town/s: Tarlay, Monghpyak

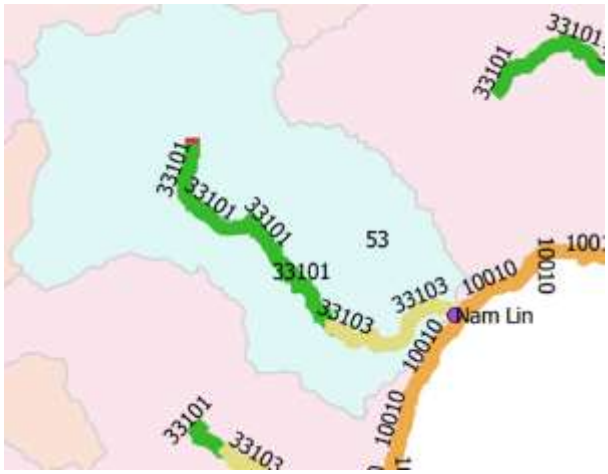
Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 1 (Nam Lin – 36 MW) Identified potential site: 0

Geomorphology and sediment	Rating	1 (4)

- The Nam Lin is a very small (19th percentile) sub-basin with a low Strahler Order tributary of the Mekong River. These characteristics combine for a low Connectivity value;
- It drains steep, hard rock areas and has the potential to produce sizeable sediment loads of sands and gravel, but rainfall is relatively low resulting in low flow input indicator Rating;
- The relatively low connectivity value and low flow input result in a low overall geomorphology rating despite a high potential sediment score;
- The sub-basin is included in the analysis as it is targeted for future hydropower development;

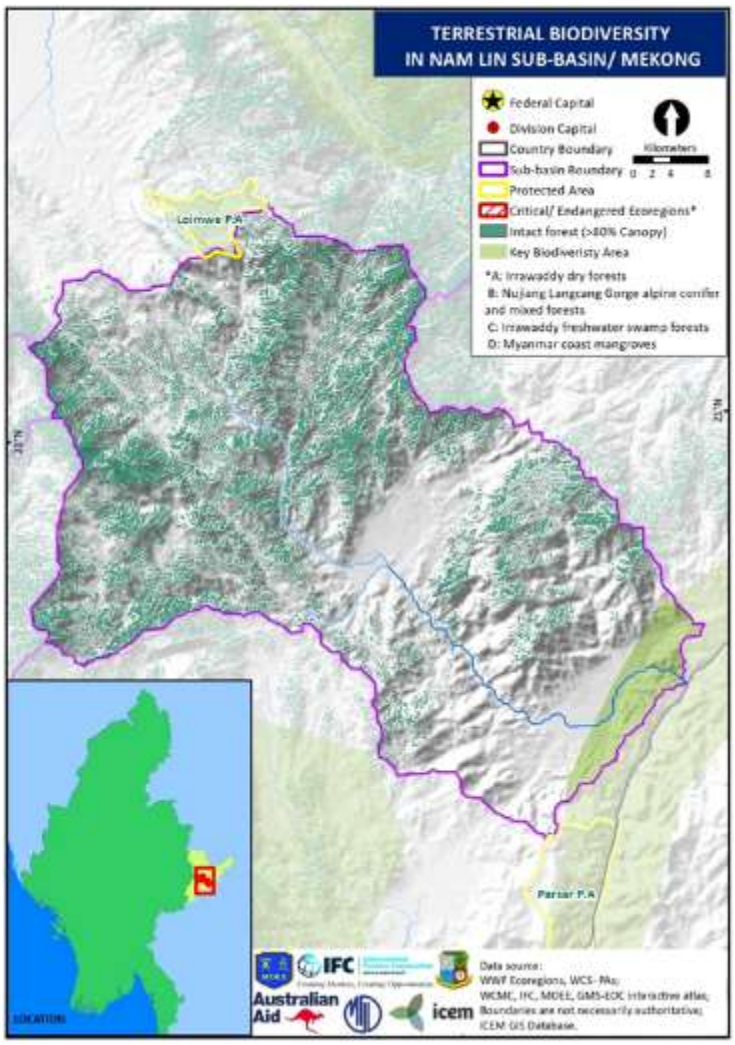
Aquatic ecology and fisheries	Ecological Value rating	2
	Human Pressure rating	2

- Nam Lin is a very small tributary of the Mekong. It contains 3 river reach types, none of which are rare, and with a very small proportion of karst reaches. The two predominant types are Medium river, in moist broadleaf forest region at low elevation, with low gradient and with floodplains.
- The mean annual flow at the confluence with the Mekong is 45 m^3/sec with a minimum flow of 7 m^3/sec.
- The sub-basin does not contain outstanding ecological features and though some threatened fish species may be present.



- Human pressures are low, with low population density, low agriculture intensity and low mining activity.
- One hydropower project is planned near the confluence with the Mekong – the Nam Lin HPP (36 MW)

Terrestrial Biodiversity	Rating	2



The Nam Lin sub-basin contains little KBA (4%) and modest intact forest (21%) cover. The KBA in the sub-basin includes the Mekong fresh water corridor that supports fish migration from species that travel between country boundaries into Laos and China.

Social, livelihoods, and significant sites	Rating	1

In the Nam Lin sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 28% of the workforce. Female-headed households, which indicate social vulnerability accounts for 19% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 61%. The ethnic minority groups in the sub-basin are Hani (Akha, Uni, Xapho, Cosung, Cote, Khape), Lahu, Lao, Shan, Yao and Yuang. On this basis, the sub-basin vulnerability rating is 1.

Conflict	Rating	1

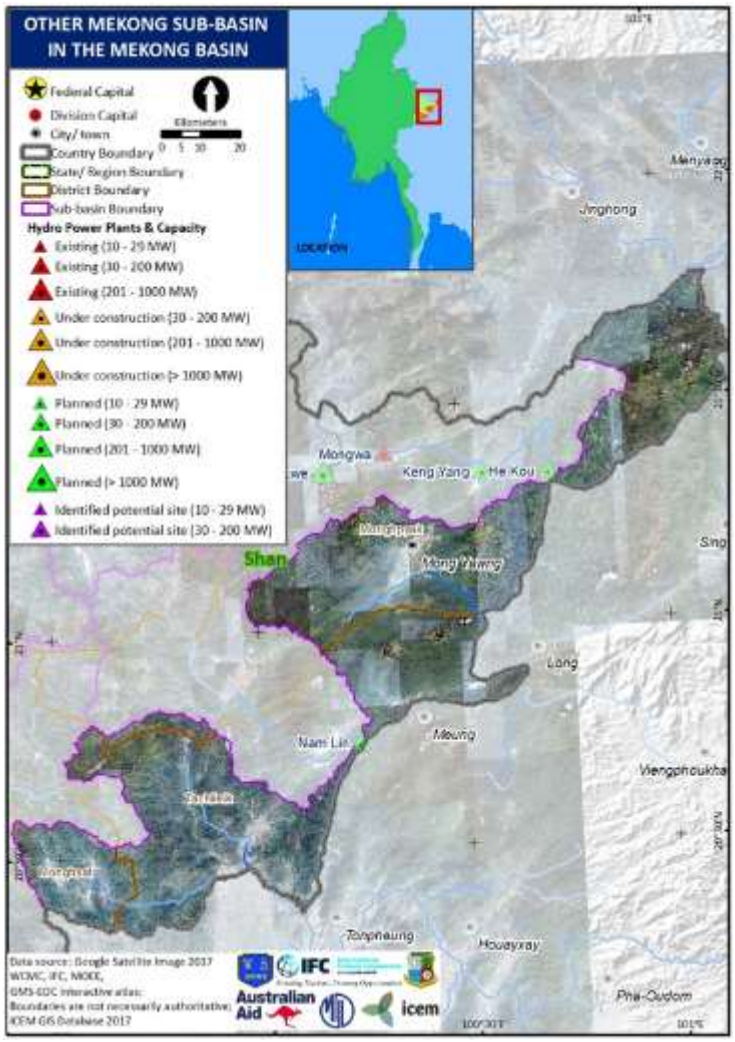
- Ceasefire and non-ceasefire armed groups active in less than half of this sub-basin (low)
- 7 estimated battle deaths 1989-2015 (very low)
- Zero 2012-2016 media-reported armed conflict incidents (very low)
- Zero estimated historical conflict-related displaced people (very low)

4.6.4 Mekong Other

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
4	5	2	1	4

Overview



Other Mekong is a medium-sized sub-basin located in the Shan state in the eastern-most region of Myanmar and shares a border with China, Laos, and Thailand.

Area: 6,534 km^2

Average rainfall: 1,531 mm

Average sub-basin outflow: 32.2 m^3/s

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	12%
Slopes 3-10 soft rock	12%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	76%
Slopes>10 intermed rock	0%

Socio-economic	Population: 79,890 Ethnic diversity: Hani (Akha, Uni, Xapho, Cosung, Cote, Khape, Lahu, Shan Economic activities: + Mining area: 7.2 km^2 (covers 0.11% of sub-basin) + Navigable waterways: None + Land use: N/A
Administrative:	States/Regions: Shan Major town/s: Mong Yawng

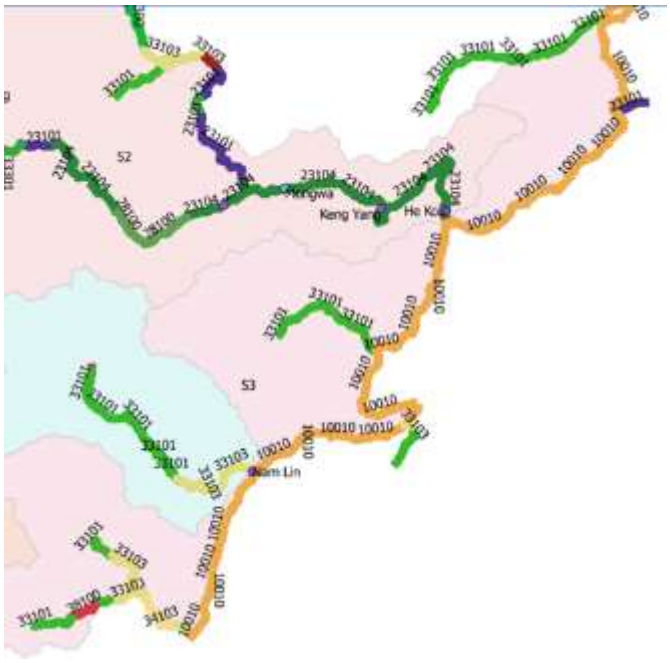
Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 0 Identified potential site: 0

Geomorphology and sediment	Rating	4

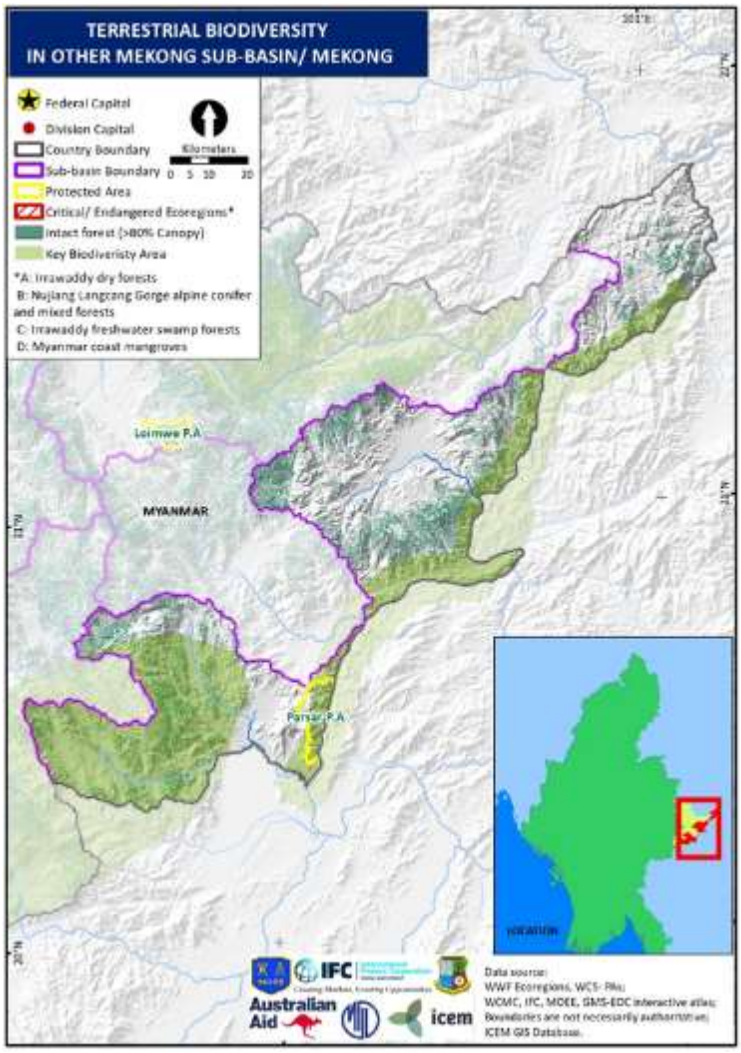
- The Mekong Other sub-basin consists of three distinct watersheds along the Mekong River with multiple Strahler Order 2 tributaries. Collectively they form a small sub-basin (38th percentile);
- There are no dams in the catchments which drain steeply sloping hard rocks;
- The high connectivity rating and potential sediment input ratings results in a geomorphology rating of 4, even though rainfall is lower than in other basins;
- This analysis does not consider the mainstem Mekong River which flows along the southern boundary of this sub-basin.

Aquatic ecology and fisheries	Ecological Value rating	5
	Human Pressure rating	3

- The Mekong Other sub-basin is effectively the Mekong mainstem along the Myanmar border from China to the Golden Triangle. It consists of 287 km of mainstem rock cut river channel. It contains 7 other river reach types of which 3 are rare, making up 13 % of the river reach lengths with only 4% flowing in karst regions. The predominant river reaches are Medium river, in moist broadleaf forest region at low elevation, with low gradient and with floodplains.
- The mean annual flow in the Mekong at the start of the sub basin is 2,005 m3/sec with a minimum flow of 357 m3/sec, and at the end of the sub-basin the mean annual flow is 2665 m^3/sec
- The Ecological values of this sub-basin is rated as very high, because of the importance of migratory species of fish and the presence of some critically endangered and endangered fish species.
- The length of the Mekong mainstem has also been recognized as a riverine KBA.
- Human pressures are medium, because despite there being very low population density along the Mekong, with little agriculture and mining pressure, there are 8 large hydropower plants upstream in China with very significant regulation of seasonal and daily flows. There is also significant commercial navigation on this stretch of the Mekong between China and Chiang Saen.
- Note: The Ecological Value rating is for the tributaries only, not for mainstem reaches



Terrestrial Biodiversity	Rating	2



Mekong Other sub-basin contains almost 40% KBA and 12% intact forest. The KBA in this sub-basin is an important habitat for small mammals and a trans-boundary corridor between China, Laos, Thailand, and Myanmar. Almost 2% of the sub-basin is made up of the Parsar protected area as well.

Social, livelihoods, and significant sites	Rating	1

In the Mekong Other sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 37% of the workforce. Female-headed households, which indicate social vulnerability accounts for 10% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 68%. The ethnic minority groups in the sub-basin are Hani (Akha, Uni, Xapho, Cosung, Cote, Khape), Lahu and Shan. On this basis, the sub-basin vulnerability rating is 1.

Conflict	Rating	4

- Multiple armed groups active in much of the sub-basin (high)
- 32 estimated battle deaths 1989-2015 (low)
- Four 2012-2016 media-reported armed conflict incidents (high)
- 3868 estimated historical conflict-related displaced people (high)

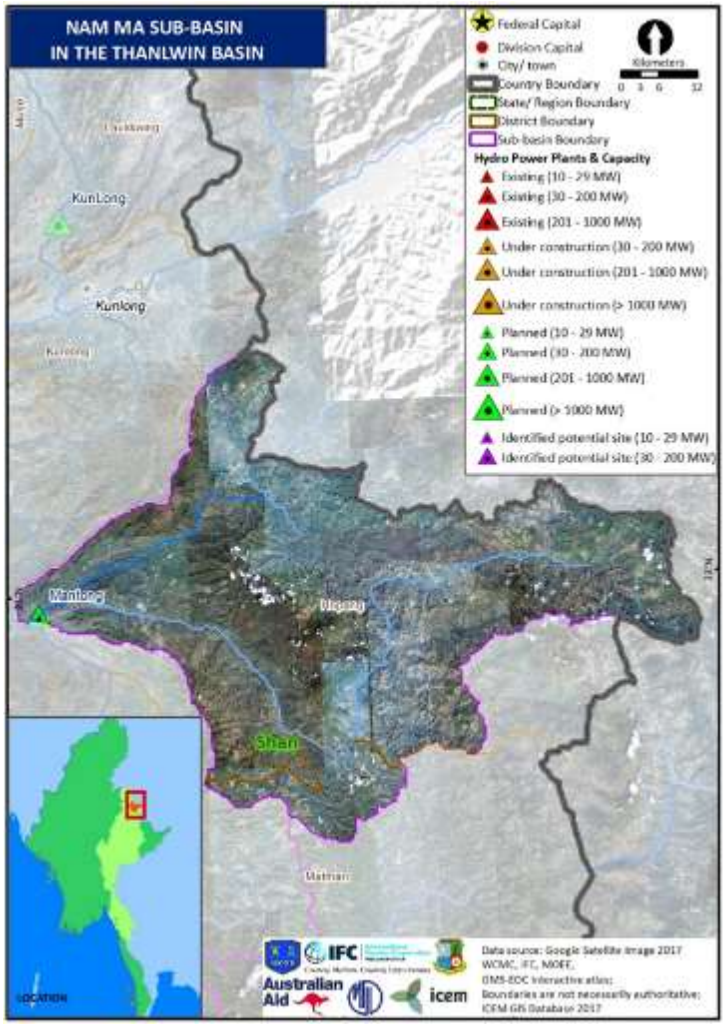
4.7 Thanlwin Basin

4.7.1 Nam Ma

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
3	2	1	N/A	2

Overview



Nam Ma is one of the smaller sub-basins, located in the Shan state in the northeastern region of Myanmar that shares a border with China.

Area: 3,425 km^2

Average rainfall: 1,406 mm

Average sub-basin outflow: 78.9 m^3/s

Topography:

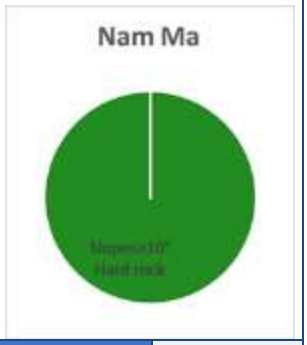
Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	0%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	100%
Slopes>10 intermed rock	0%

Socio-economic	Population: 24,479 Ethnic diversity: Wa, Parauk, Shan Economic activities: + Mining area: 0.5 km^2 (covers 0.01% of sub-basin) + Navigable waterways: None + Land use: Plantation (6%); Agriculture-Rainfed-Single (6.9%),
Administrative:	States/Regions: Shan Major town/s: Mongmao, Hsawng Hpa, Hkun Mar, Yawng Lin, Pangwaun, Lin Haw, Man Tun

Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 1 (Mantong – 225 MW) Identified potential site: 0

Geomorphology and sediment	Rating	3

- Nam Ma is a small sub-basin (26th percentile) situated within the Shan Plateau with a Strahler Order 2 mainstem;
- It receives relatively low rainfall and its small size and low Strahler contribute to low connectivity and flow input indicator scores, even though there are no hydropower projects in the sub-basins;
- It has a high sediment potential owing to its catchment being located completely within the mountainous Shan Plateau;
- Extensive deforestation has occurred within the basin and there are sediment deposits evident at the confluence of the Thanlwin in satellite images. Current land use practices are not included in this analysis.

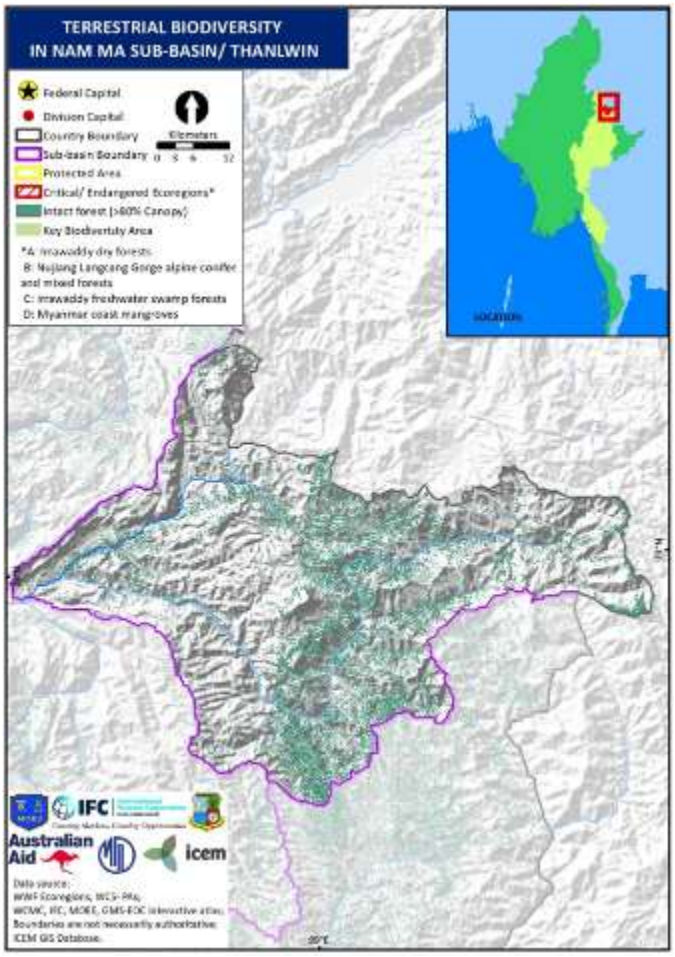


Aquatic ecology and fisheries	Ecological Value rating	2
	Human Pressure rating	2

- The Nam Ma is a small left bank tributary of the Upper Thanlwin. It contains 2 river reach types, 1 of which is rare covering 25% of the reach lengths. The predominant type is Medium river, in moist broadleaf forest region at low elevation, with low gradient, with a substantial length of moist broadleaf forest region at high elevation.

- The mean annual flows at the confluence with the Thanlwin is 78 m^3/sec with a minimum flow of 11 m^3/sec.
- There are no outstanding aquatic ecological features and no KBAs in this sub basin
- Human pressures are also low, with low rural population density, agricultural intensity and mining activity.
- One hydropower project is planned the Mantong HPP (225 MW)

Terrestrial Biodiversity	Rating	1



The Nam Ma sub-basin contains no KBA and modest intact forest (16%) cover. With no protected areas or critically endangered ecoregions, it is a not a particularly notable region from a biodiversity standpoint and is given a rating of 1.

Social, livelihoods, and significant sites	Rating	N/A
The ethnic minority groups in the sub-basin are Wa, Parauk and Shan		

Conflict	Rating	2

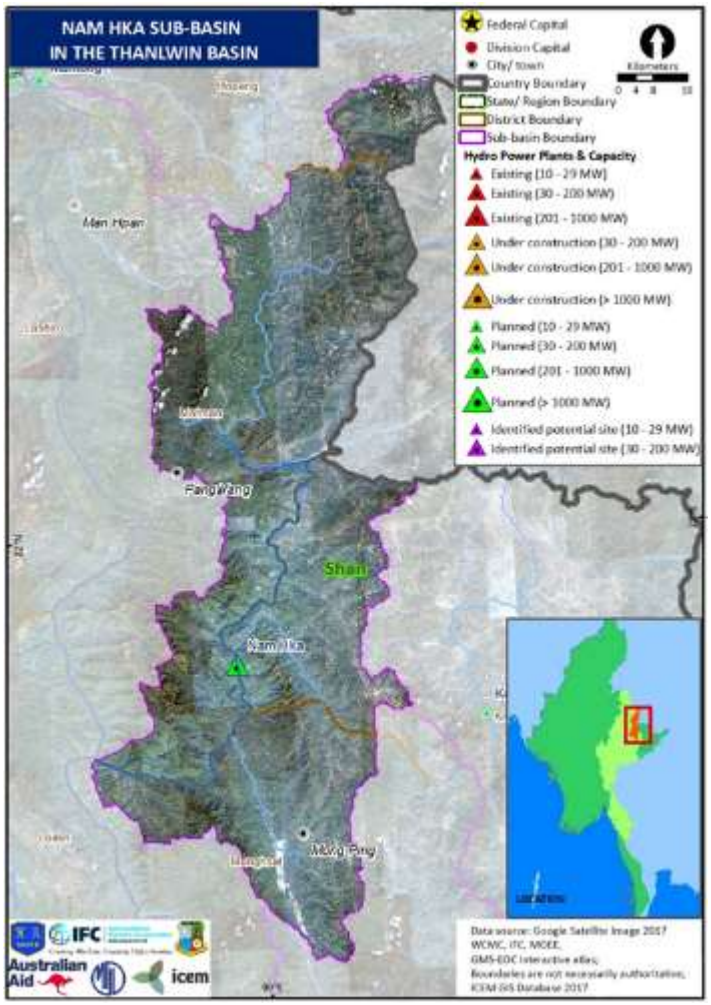
- Sub-basin is in Wa SAD (medium)
- Four estimated battle deaths 1989-2015 (very low)
- Zero 2012-2016 media-reported armed conflict incidents (very low)
- Zero estimated historical conflict-related displaced people (very low)

4.7.2 Nam Hka

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
4	2	2	2	2

Overview



Nam Hka is a medium-sized sub-basin located in the Shan state in the eastern part of Myanmar and shares a border with China.

Area: 8,074 km^2

Average rainfall: 1,356 mm

Average sub-basin outflow: 202 m^3/s

Topography:

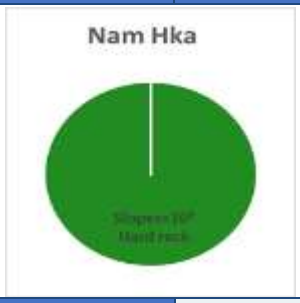
Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	0%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	100%
Slopes>10 intermed rock	0%

Socio-economic	Population: 19,732 Ethnic diversity: Shan, Wa (Kawa) Economic activities: + Mining area: 1.3 km^2 (covers 0.02% of sub-basin) + Navigable waterways: None + Land use: Plantation (2.6%); Agriculture-Rainfed-Single (6%), Irrigated – Double (0.1%)
Administrative:	States/Regions: Shan Major town/s: Mong Ping, Pang Yang

Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 1 (Nam Hka – 210 MW) Identified potential site: 0

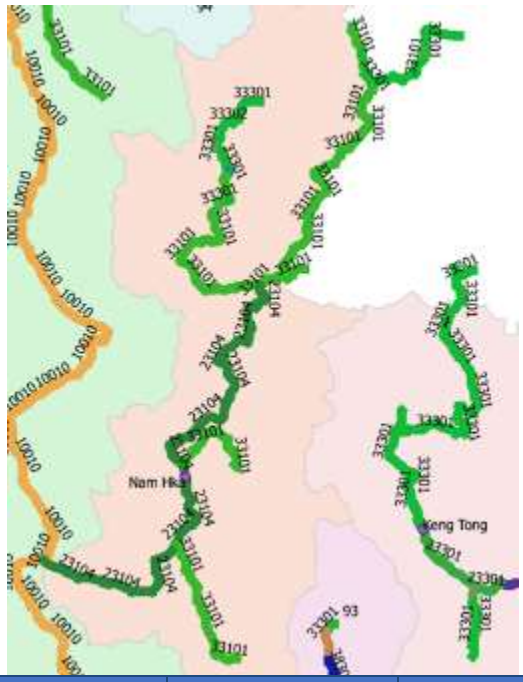
Geomorphology and sediment	Rating	4

- The Nam Hka is a medium size sub-basin (46th percentile) that lies next to the Upper and Middle Thanlwin sub-basins and has been separated out due to its potential hydropower development;
- The Nam Hka is a Strahler Order 3 river, which has high sediment input potential owing to its location within the steep Shan Plateau
- It receives relatively low rainfall compared to other sub-basins in Myanmar, but is unregulated and maintains good connectivity.

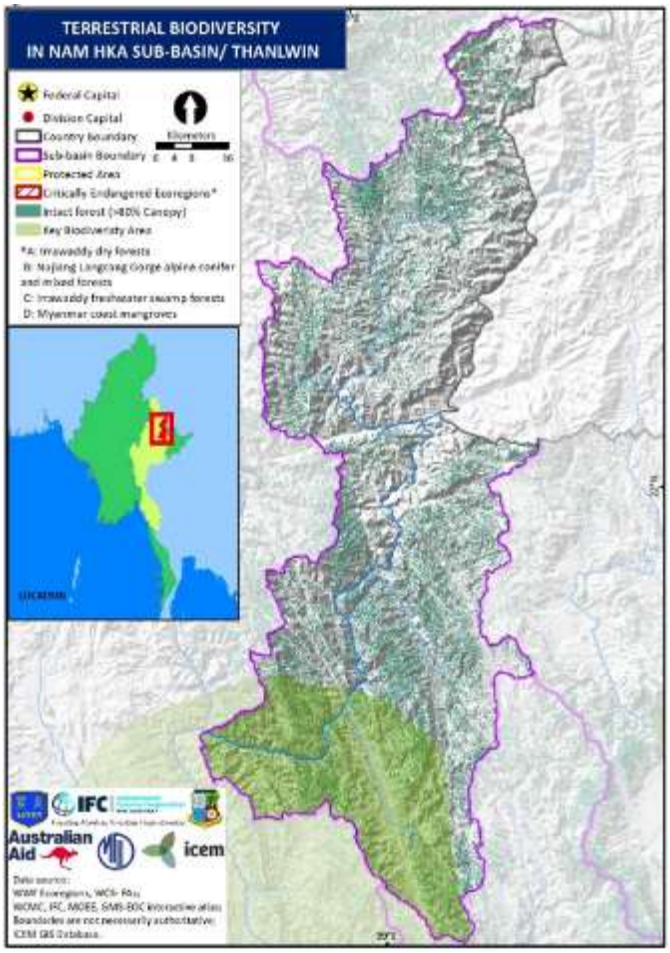


Aquatic ecology and fisheries	Ecological Value rating	2
	Human Pressure rating	2

- The Nam Hka is a small left bank tributary of the Upper Thanlwin. It contains 4 river reach types, 1 of which is rare covering less than 1% of the reach lengths. The predominant types are Large river, in moist broadleaf forest region at low elevation, with sediment and Medium river, in moist broadleaf forest region at low elevation, with low gradient, with a substantial length of moist broadleaf forest region at high elevation. There are no karst reaches.
- The mean annual flows at the confluence with the Thanlwin is 202 m^3/sec with a minimum flow of 25 m^3/sec.
- There are no outstanding aquatic ecological features and no KBAs in this sub basin
- Human pressures are also low, with low rural population density, agricultural intensity and mining activity.
- One hydropower project is planned the Nam Hka (210 MW)



Terrestrial Biodiversity	Rating	2



The Nam Hka sub-basin contains modest KBA (21%) and intact forest (19%) cover. The KBA in the sub-basin is a habitat for the big-headed turtle and the impressed tortoise.

Social, livelihoods, and significant sites	Rating	2

In the Nam Hka sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 25% of the workforce. Female-headed households, which indicate social vulnerability accounts for 10% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 22%. The ethnic minority groups in the sub-basin are Kachins (Singpho), Lao, Shan and Yao. On this basis, the sub-basin vulnerability rating is 2.

Conflict	Rating	2

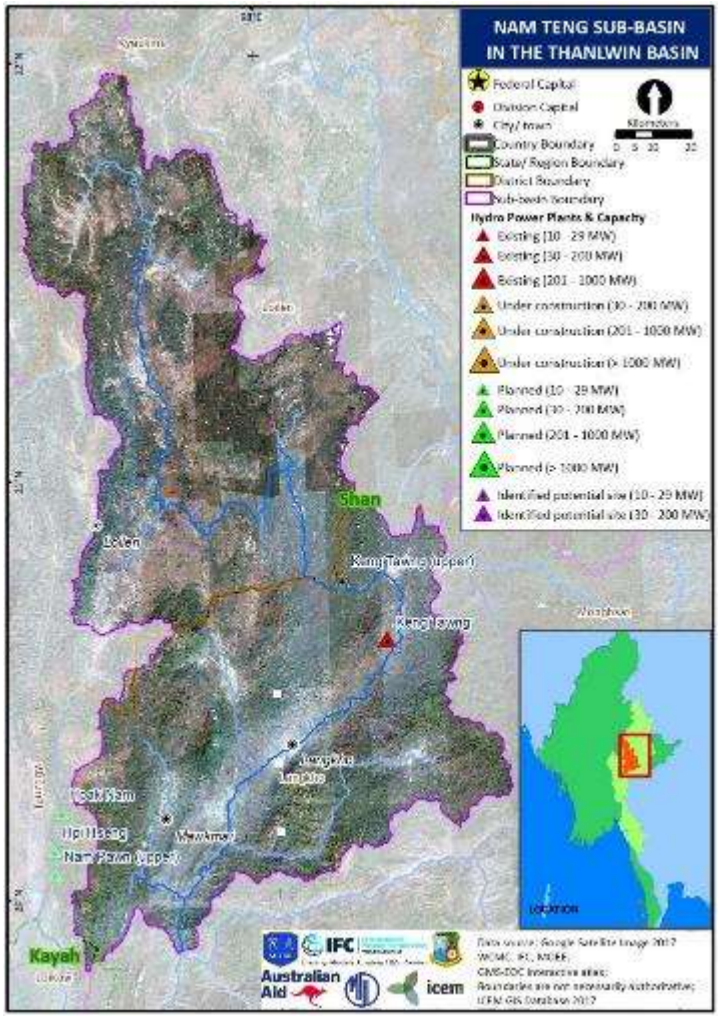
- Approximately half of the sub-basin is UWSA territory and Wa SAZ (medium)
- Zero estimated battle deaths 1989-2015 (very low)
- Two 2012-2016 media-reported armed conflict incidents (medium)
- Zero estimated historical conflict-related displaced people (very low)

4.7.3 Nam Teng

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
1	2	2	4	4

Overview



Nam Teng is a medium-sized sub-basin located in the Kayah and Shan states in the eastern region of Myanmar.

Area: 15,386 km^2

Average rainfall: 1,475 mm

Average sub-basin outflow: 334.7 m^3/s

Topography:

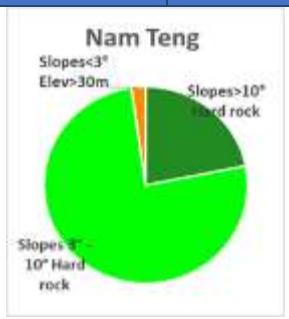
Type	% cover of sub-basin
Slopes 3-10 Hard rock	76%
Slopes 3-10 soft rock	0%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	2%
Slopes>10 hard rock	22%
Slopes>10 intermed rock	0%

Socio-economic	Population: 339,258 Ethnic diversity: Karen, Kayah, Shan, Wa (Kawa) Economic activities: + Mining area: 4.1 km^2 (covers 0.03% of sub-basin) + Navigable waterways: None + Land use: Plantation (0.4%); Agriculture-Rainfed-Single (17.4%), Irrigated – Double (0.2%)
Administrative:	States/Regions: Kayah, Shan Major town/s: Langkho, Mawkmai

Status of hydropower development	Existing: 1 (Keng Tawng – 54 MW) Under Construction: 1 (Keng Tawng upper – 51 MW) Planned: 0 Identified potential site: 0

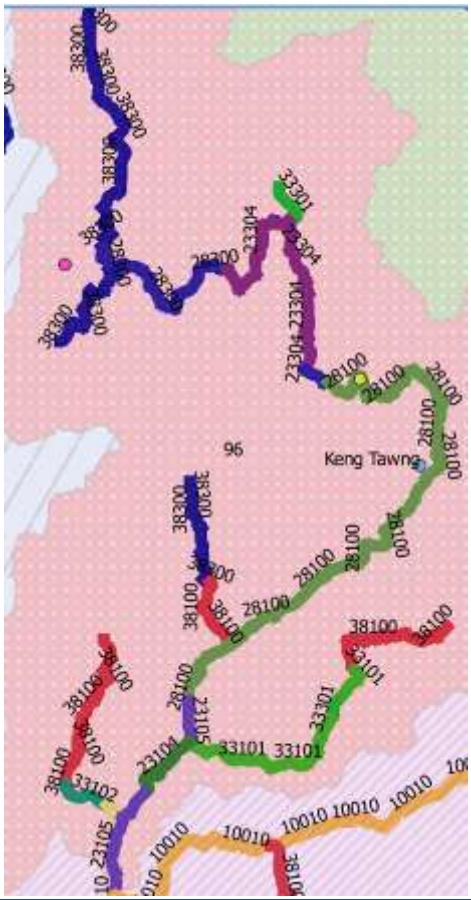
Geomorphology and sediment	Rating	3

- Nam Teng is a large (70th percentile), high Strahler Order (3) sub-basin that predominantly drains the high, undulating area of the Shan Plateau before flowing south into steeper terrain;
- There are two hydropower projects in the catchment that regulate about 40% of the catchment, and have water storage potential of 1 – 2 weeks which lowers the connectivity of the sub-basin;
- The sub-basin has moderate rainfall and sediment input potential, resulting in an overall medium geomorphology rating.

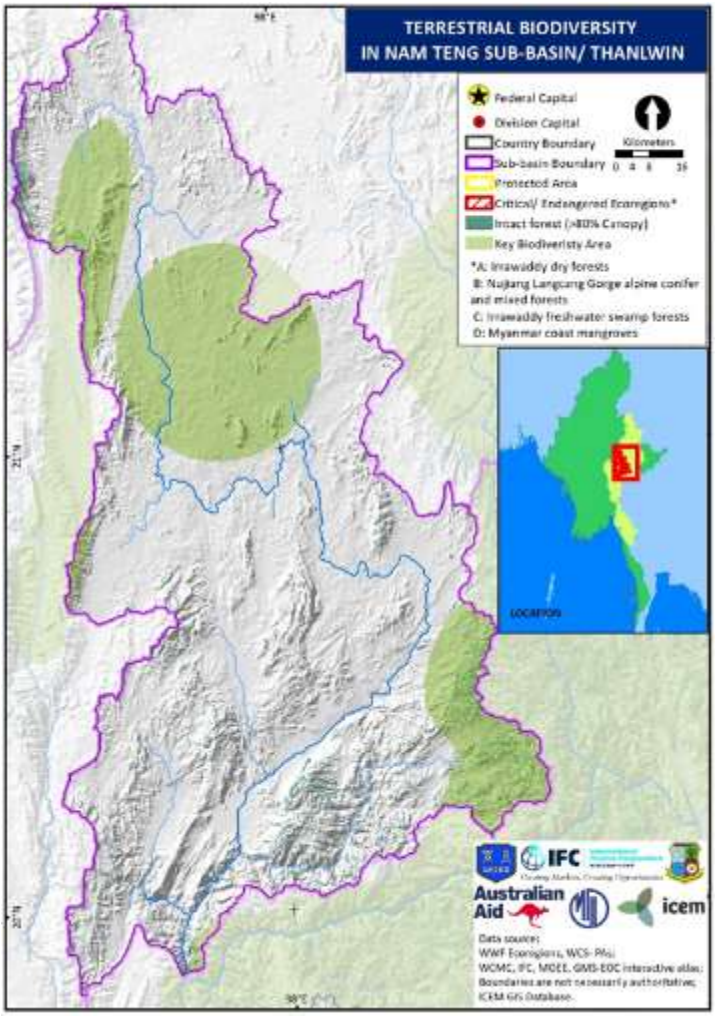


Aquatic ecology and fisheries	Ecological Value rating	2
	Human Pressure rating	3

- The Nam Teng is a large tributary of the Thanlwin, entering on the right bank, 160 km above the Nam Pawn confluence. Its river reaches are diverse with 11 types of which 6 are rare, making up about 57% of the reach type lengths. Over 70% of these reach types lie in karst regions, both large and medium at low and high elevation. Of the common reach types, Large and Medium river, in moist broadleaf forest region at low elevation, with low gradient are found.
- The mean annual flows at the confluence are 333 m^3/sec with minimum flows at 60 m^3/sec
- The sub-basin is not reported to have endemic or threatened species of fish, but with the high proportion of karst reaches, this may be due to absence of relevant surveys.
- There is one KBA in the Nam San valley in the upper part of the sub-basin.
- Human pressures on the aquatic ecology are medium, with moderate rural populations and cultivation in the valleys, and some shifting cultivation and loss of forest cover in the hillsides.
- There is one hydropower plant existing Keng Tawng (54 MW) and one under construction Keng Tawng upper (51 MW) Both are considered to have a relatively low impact upon the aquatic ecology, the existing dam with a small length of dewatered river reach between dam and power station and the upper dam having a reservoir of 11 km.



Terrestrial Biodiversity	Rating	2



The Nam Teng sub-basin contains moderate KBA (23%) and little intact forest (2%) cover. The KBA in the sub-basin is a habitat for several endemic species including the soft-shell turtle and various fish species.

Social, livelihoods, and significant sites	Rating	4

In the Nam Teng sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 35% of the workforce. Female-headed households, which indicate social vulnerability accounts for 21% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 44%. The ethnic minority groups in the sub-basin are Karen, Kayah, Shan and Wa (Kawa). On this basis, the sub-basin vulnerability rating is 4.

Conflict	Rating	5

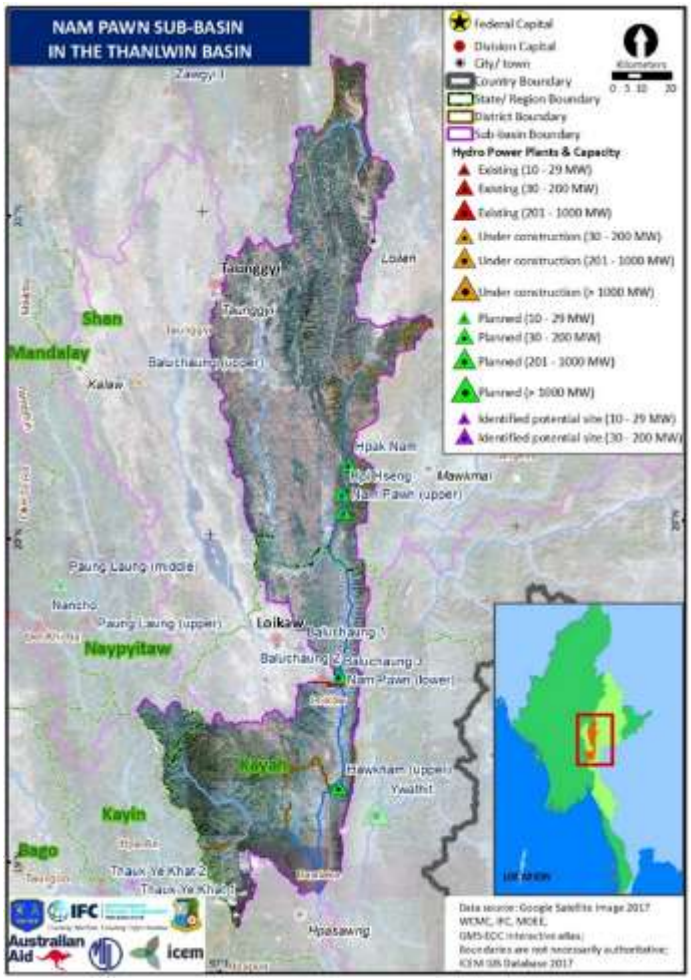
- Multiple armed groups influential in much of the sub-basin (high)
- 151 estimated battle deaths 1989-2015 (high)
- 21 2012-2016 media-reported armed conflict incidents (very high)
- 29,977 estimated historical conflict-related displaced people (very high)

4.7.4 Nam Pawn

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
5	3	1	4	4

Overview



Nam Pawn is a medium-sized sub-basin located in the Kayah, Kayin, and Shan states in the central region of Myanmar.

Area: 11,572 km^2

Average rainfall: 1,446 mm

Average sub-basin outflow: 402.3 m^3/s

Topography:

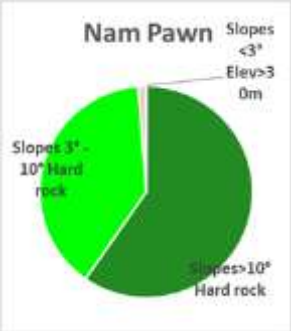
Type	% cover of sub-basin
Slopes 3-10 Hard rock	39%
Slopes 3-10 soft rock	1%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	60%
Slopes>10 intermed rock	0%

Socio-economic	Population: 435,364 Ethnic diversity: Karen, Kayah, Shan Economic activities: + Mining area: 11.6 km^2 (covers 0.13% of sub-basin) + Navigable waterways: None + Land use: Plantation (0.7%); Agriculture-Rainfed-Single (21.8%), Rainfed-Double (0.5%), Irrigated-Single (0.3), Irrigated – Double (0.4%)
Administrative:	States/Regions: Kayah, Kayin, Shan Major town/s: Loilen

Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 5 (Hawkham (upper) – 180 MW, Hpak Nam – 105 MW, Hpi Hseng – 45 MW, Nam Pawn (lower) – 105 MW, Nam Pawn (upper) – 150 MW) Identified potential site: 0

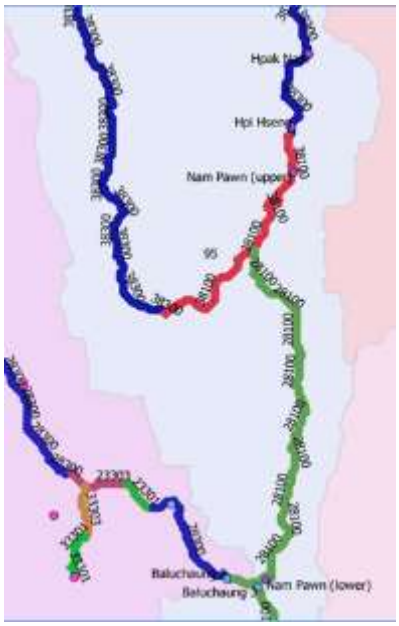
Geomorphology and sediment	Rating	5

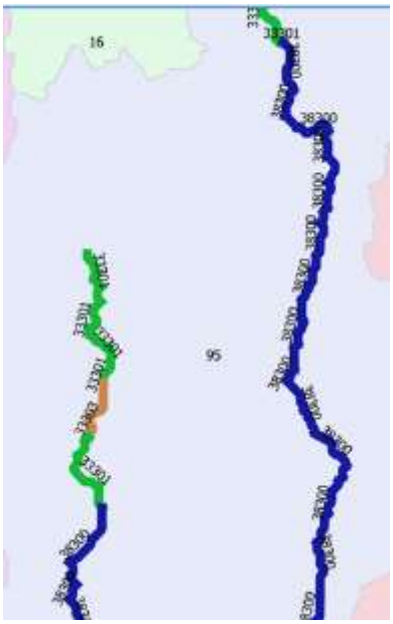
- The large (61st percentile) Nam Pawn sub-basin includes both undulating and steeply sloping areas of the Shan Plateau;
- Maximum Strahler Order is 3, and inflows include the regulated flow from the Baluchaung sub-catchment which joins the Nam Pawn in the middle of the sub-basin;
- Rainfall is moderate, and connectivity is considered high due to the large basin size, high Strahler Order, and lack of any hydropower developments (does not consider regulation of Baluchaung);
- Potential sediment input is high resulting in an overall geomorphology rating of 5.



Aquatic ecology and fisheries	Ecological Value rating	3
	Human Pressure rating	3

- The Nam Pawn is a long tributary of the Thanlwin lying between the Balachaung and the Thanlwin mainstem. The sub-basin consists of two parts, the lower watershed after the confluence with the Balachaung down to the Thanlwin, and the upper watershed above the Balachaung confluence, where the river splits into two main branches that extend for a further 200 km.

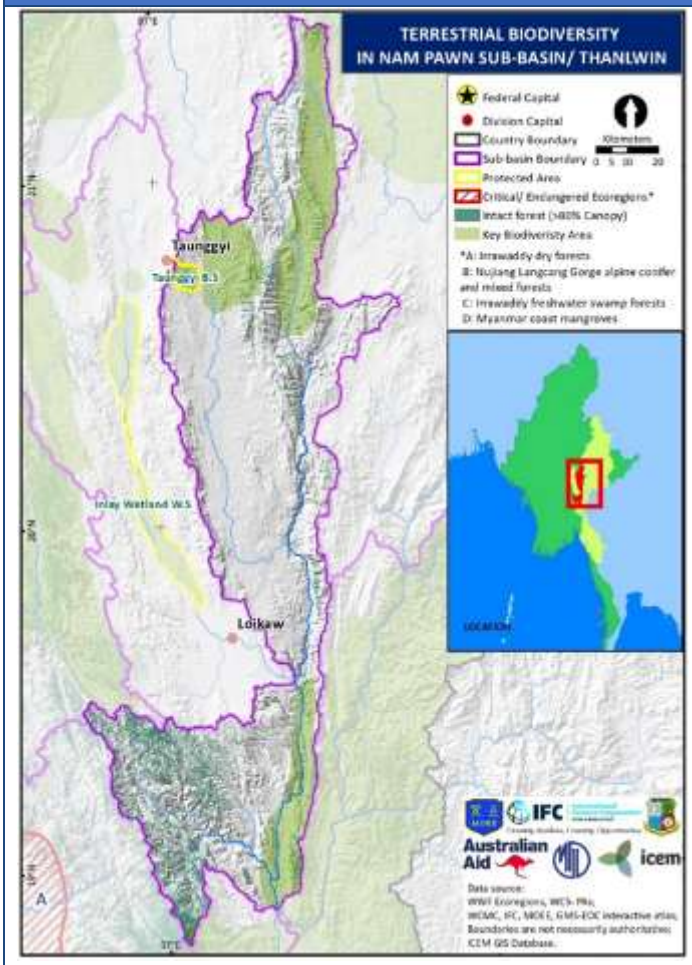




- The Nam Pawn sub-basin contains 9 river reach types of which 4 are rare, making up 55% of the reach type lengths. 65% of the reach types lie in karst regions. In the lower watershed, the predominant reach types are Large and medium rivers, in moist broadleaf forest region at low elevation, at low gradient and with floodplains, but before the confluence with the Balachaung, the rivers in karst regions start and continue up both branches of the upper watershed. At the very top of both branches the river starts as Medium river, in moist broadleaf forest region at high elevation, with low gradient.
- The mean annual flows of the Nam Pawn at the confluence with the Thanlwin is 400 m^3/sec with a minimum flow of 70 m^3/sec.
- The sub-basin is not within a recognized area of endemism but threatened species of fish are found in the sub-basin. There are two terrestrial KBAs in the upper parts of the watershed.

- Human pressures are medium with low agricultural intensity, medium mining activity, and loss of forest cover.
- 5 hydropower projects are planned in the upper watershed of this sub-basin - Hawkham (upper), Nam Pawn (lower), Nam Pawn (upper), Hpak Nam, Hpi Hseng.

Terrestrial Biodiversity	Rating	1



The Nam Pawn sub-basin contains moderate KBA (20%) and little intact forest (6%) cover. The KBA in the sub-basin is a habitat for endemic species of geckos and other cave species, including several invertebrates. The Taunggyi Bird Sanctuary makes up around 0.5% of the sub-basin.

Social, livelihoods, and significant sites	Rating	4

In the Nam Pawn sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 33% of the workforce. Female-headed households, which indicate social vulnerability accounts for 23% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 50%. The ethnic minority groups in the sub-basin are Karen, Kayah and Shan. On this basis, the sub-basin vulnerability rating is 4.

Conflict	Rating	4

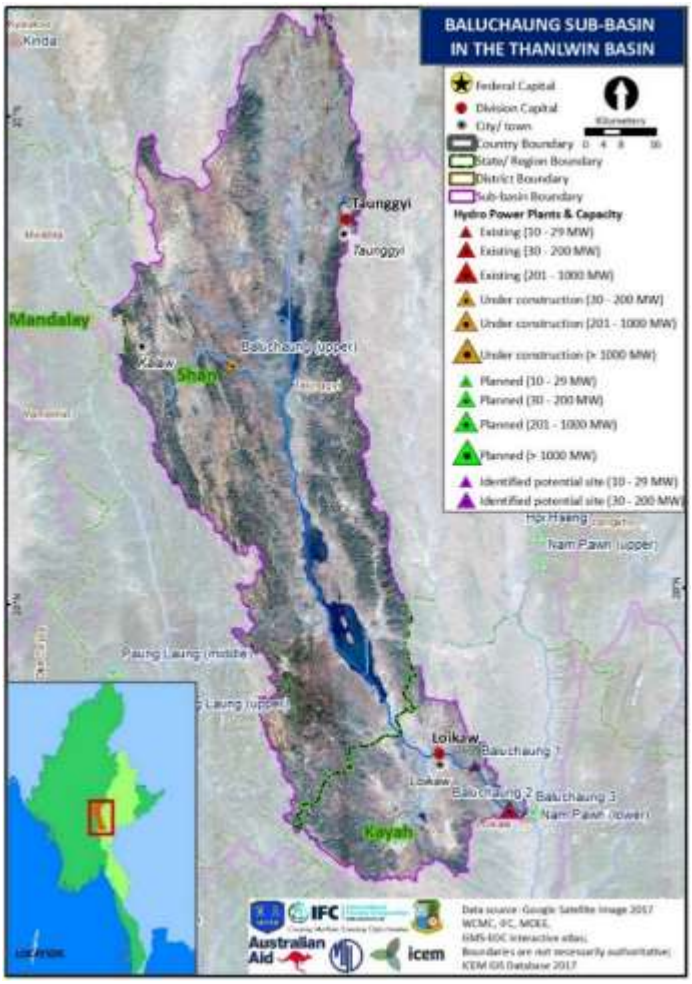
- Multiple Pa'O and Shan armed groups and Pa'O SAZ (high)
- 34 estimated battle deaths 1989-2015 (low)
- Eight 2012-2016 media-reported armed conflict incidents (high)
- 19,900 estimated historical conflict-related displaced people (very high)

4.7.5 Baluchaung

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
2	5	2	2	3

Overview



Baluchaung is a medium-sized sub-basin located in the Kayah and Shan states in the center of the country.

Area: 7,837 km^2

Average rainfall: 1,493 mm

Average sub-basin outflow: 151.6 m^3/s

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	72%
Slopes 3-10 soft rock	0%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	9%
Slopes>10 hard rock	20%
Slopes>10 intermed rock	0%

Socio-economic	Population: 892,747 Ethnic diversity: Karen, Kayah, Shan Economic activities: + Mining area: 6.1 km^2 (covers 0.08% of sub-basin) + Navigable waterways: None + Land use: Plantation (1.7%); Agriculture-Rainfed-Single (39.9%), Rainfed-Double (0.7%), Irrigated-Single (0.2%), Irrigated – Double (2.7%), Irrigated-Triple (0.3%)
Administrative:	States/Regions: Kayah, Mandalay, Shan Major town/s: Kalaw, Loikaw, Taunggyi

Status of hydropower development	Existing: 3 (Baluchaung 1 – 28 MW, Baluchaung 2 – 168 MW, Baluchaung 3- 52 MW) Under Construction: 1 (Baluchaung upper – 30 MW) Planned: 0 Identified potential site: 0

Geomorphology and sediment	Rating	2

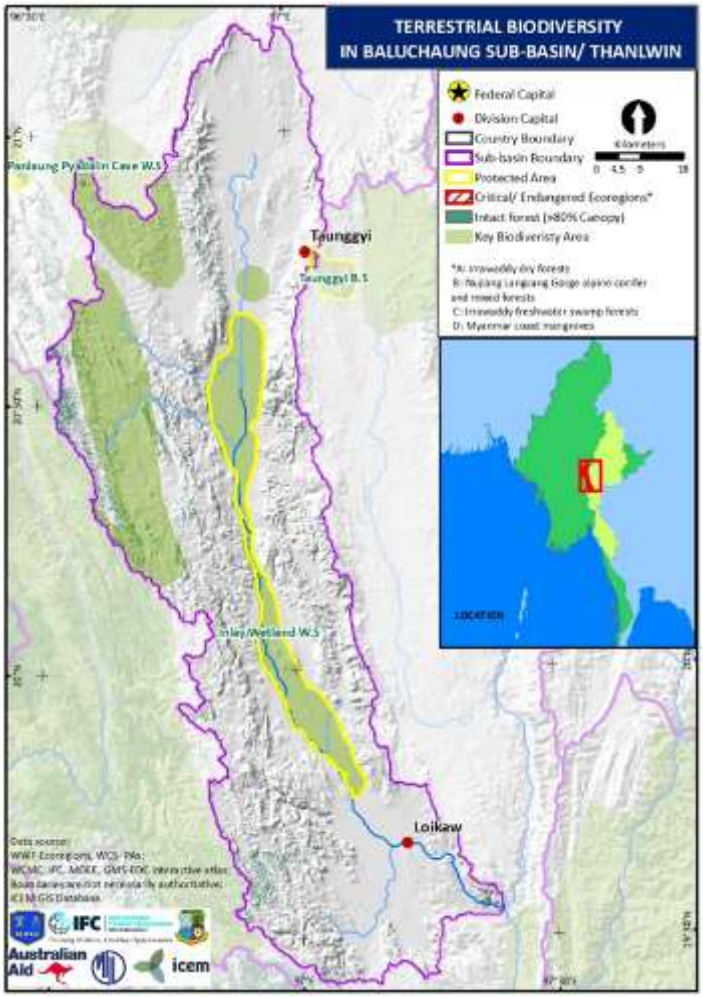
- The Baluchaung sub-basin is a medium (42nd percentile) sized catchment that drains the undulating Shan Plateau;
- IT receives moderate rainfall, and has a moderate sediment supply potential;
- The connectivity of the river is altered by the presence of a hydropower cascade in the lower catchment another hydropower project in the headwaters. Flow in the river is also altered due to the operation of the Moby Dam for irrigation and regulating flows to the Baluchaung cascade;
- The cascade diverts water out of the river resulting in extended dewatered reaches that disrupt the connectivity of the system.

Aquatic ecology and fisheries	Ecological Value rating	5
	Human Pressure rating	5

- The Baluchaung river flows into the Nam Pawn, a west bank tributary of the Thanlwin. The sub-basin has very high ecological value due to the unique feature of Inle Lake which lies in the top part of the sub-basin. It has 8 river reach types, all of which are rare, and over 60% of which lie in karst limestone areas. In the upper part of the sub-basin, the predominant reaches are medium rivers in karst at high elevation and montane. After Inle Lake it flows through Medium river, in moist broadleaf forest region at high elevation, with low gradient and with floodplains. In the central part of the sub-basin the Moby irrigation dam has created another large lake downstream of Inle Lake. Towards the end of the sub-basin the river again flows through karst at high elevation.
- At its confluence with the Nam Pawn the mean annual flow in the Baluchaung river is 151 m^3/sec with a minimum flow of 30 m^3/sec
- Inle Lake is recognized as having a unique biodiversity of fish and molluscs, with many endemic species, probably because of its high karst location.
- The Baluchaung sub-basin is under high human pressure, with a combination of moderate mining and agricultural intensity, high rural population density and use of Inle Lake for tourism and fisheries, and increasing water pollution.

- There are three run-of river hydropower projects driven by the storage capacity of the Moby dam at the bottom end of the sub-basin – Baluchaung 1 (28 MW), Baluchaung 2 (168 MW) and Baluchaung 3 (52 MW). These three dams in cascade have eliminated any connectivity between the Baluchaung and the rest of the Thanlwin system. Together they have created a 22-km dewatered stretch of the river between the dams and the power houses.
- A fourth hydropower project is under construction, Baluchaung upper (30 MW) which would have a reservoir of 10 km and 3 km dewatered zone. It is located on an upper branch of the Baluchaung opposite to Inle Lake.

Terrestrial Biodiversity	Rating	2



Over 20% of the Baluchaung sub-basin is composed of KBA that is home to several endemic and endangered species of birds, including the Giant Nuthatch. A small portion of the sub-basin (7%) is classified as a protected area (Taunggyi Bird Sanctuary and Inlay Wetland Wildlife Sanctuary) as well to support the endangered species. However, with less than 2% intact forest present in the sub-basin, it receives a biodiversity rating of 2.

Social, livelihoods, and significant sites	Rating	2

In the Baluchaung sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 28% of the workforce. Female-headed households, which indicate social vulnerability accounts for 23% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 59%. The ethnic minority groups in the sub-basin are Karen, Kayah and Shan. On this basis, the sub-basin vulnerability rating is 2.

Conflict	Rating	3

- Less than half of the sub-basin is influenced by armed groups including the KNPP and the Pa'O SAZ (medium)
- Nine estimated battle deaths 1989-2015 (low)
- Two 2012-2016 media-reported armed conflict incidents (low)
- 7220 estimated historical conflict-related displaced people (very high)

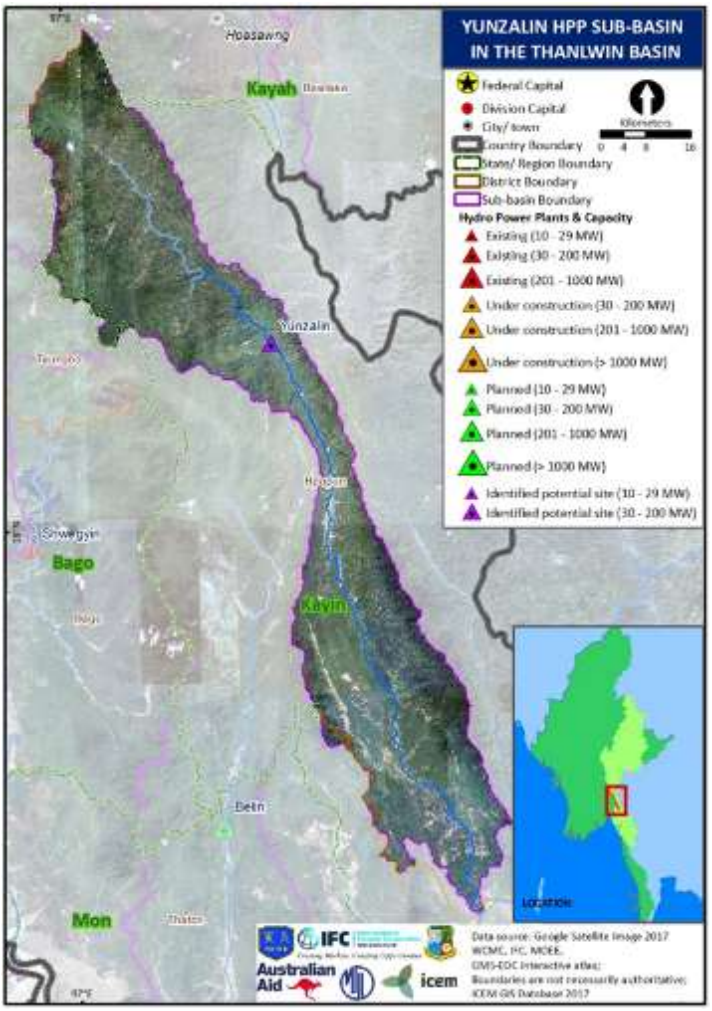
Baluchaung 3 HPP discharges water into the Nam Pawn River.

4.7.6 Yunzalin

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
2	4	3	N/A	3

Overview



Yunzalin is a relatively small sub-basin that falls within the Kayah and Kayin states in the southern region of the main body of Myanmar.

Area: 3,036 km^2

Average rainfall: 1,709 mm

Average sub-basin outflow: 128.6 m^3/s

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	25%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	2%
Slopes>10 hard rock	72%
Slopes>10 intermed rock	0%

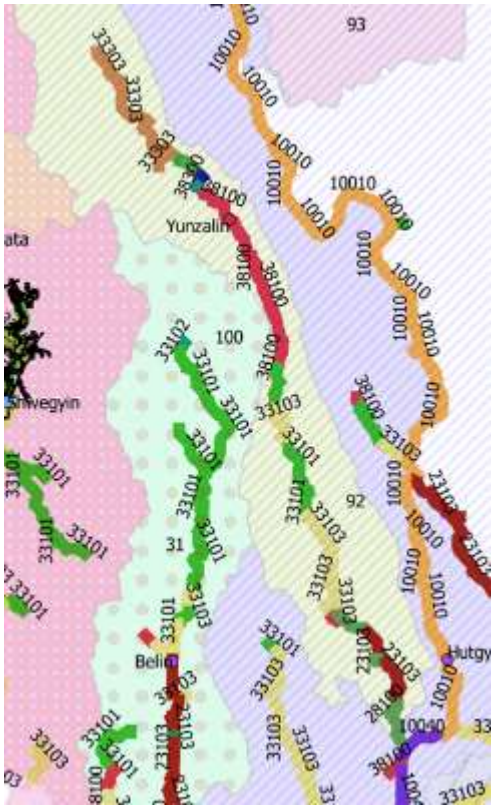
Socio-economic	Population: 8,076 Ethnic diversity: Chin (Asho) Economic activities: + Mining area: No + Navigable waterways: None + Land use: Plantation (0.1%); Agriculture-Rainfed-Single (2.3%), Irrigated-Single (0.6%), Irrigated – Double (0.2%)
Administrative:	States/Regions: Bago, Kayah, Kayin, Mon Major town/s: Hpapun
Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 0 Identified potential site: 1 (Yunzalin – 100 MW)

Geomorphology and sediment	Rating	2 (3)

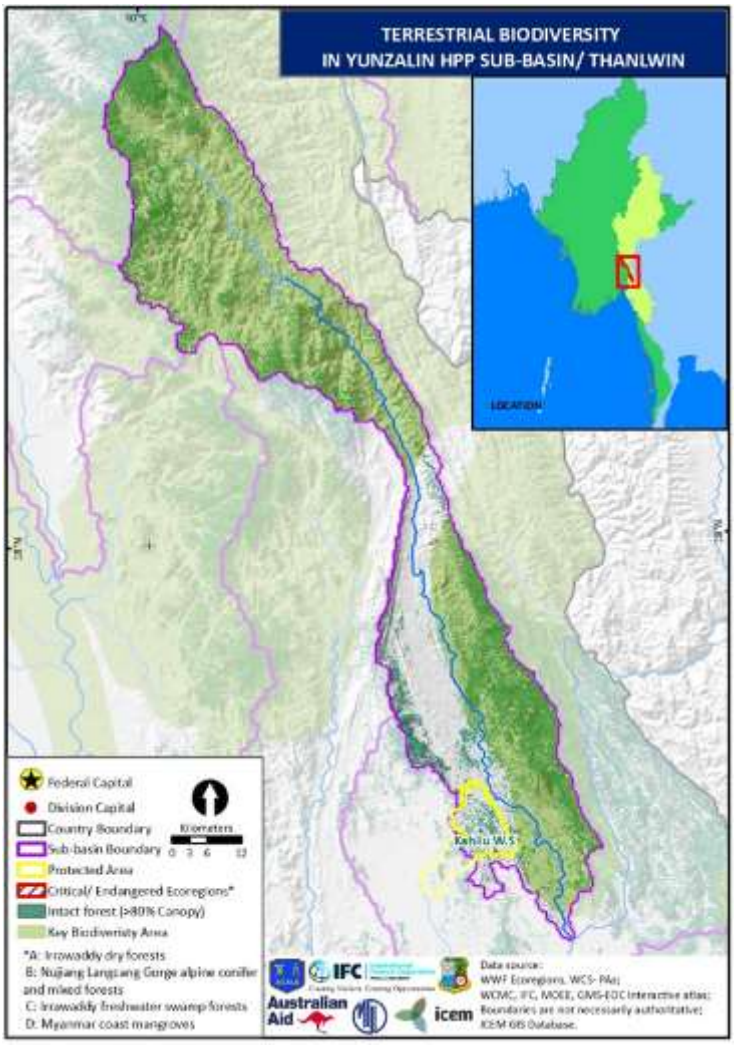
- The Yunzalin is a small (21st percentile), narrow basin situated between the Bilin and Thanlwin basins that flows directly to the sea;
- It is not presently developed for hydropower but has moderate rainfall and low Strahler Order (2) limiting its Inflow and Connectivity scores;
- The sub-basin has high sediment production potential, and provides sediment input directly to the coastal zone;
- Similar to other small sub-basins identified for potential hydropower development its geomorphic rating would likely increase if it were included in one of the larger neighbouring basins.

Aquatic ecology and fisheries	Ecological Value rating	4
	Human Pressure rating	2

- The Yunzalin sub-basin is a small tributary of the Lower Thanlwin, flowing north to south parallel to the Thanlwin. It contains 10 river reach types of which 5 are rare, covering 24.5% of the reach lengths. The commonest reaches are Large and medium river, in moist broadleaf forest region at low elevation, with floodplains and at low gradient, and large and medium rivers in karst region. 35% of the river reaches lie in karst region.
- The mean annual flows at the confluence with the Lower Thanlwin are 127 m^3/sec with a minimum flow of 11.7 m^3/sec.
- The karst area reaches may contain endemic fish species.
- Most of the sub-basin could be contained within the concept of the Thanlwin Peace Park KBA
- Human pressures on the sub-basin include a high rural population with increasing agriculture intensity in the river valley
- One hydropower project is planned at Yunzalin (100 MW)



Terrestrial Biodiversity	Rating	3



There is significant KBA (75%) presence in the Yunzalin sub-basin and moderate intact forest (30%) cover as well. The KBA is a habitat for tiger and elephants and includes the Shwe Kyin and Paung Laung biodiversity corridors as well. The protected Kahilu Wildlife Sanctuary is located within the sub-basin and makes up 3% of the total area.

Social, livelihoods, and significant sites	Rating	N/A
The ethnic minority groups in the sub-basin are Chin (Asho)		
Conflict	Rating	3

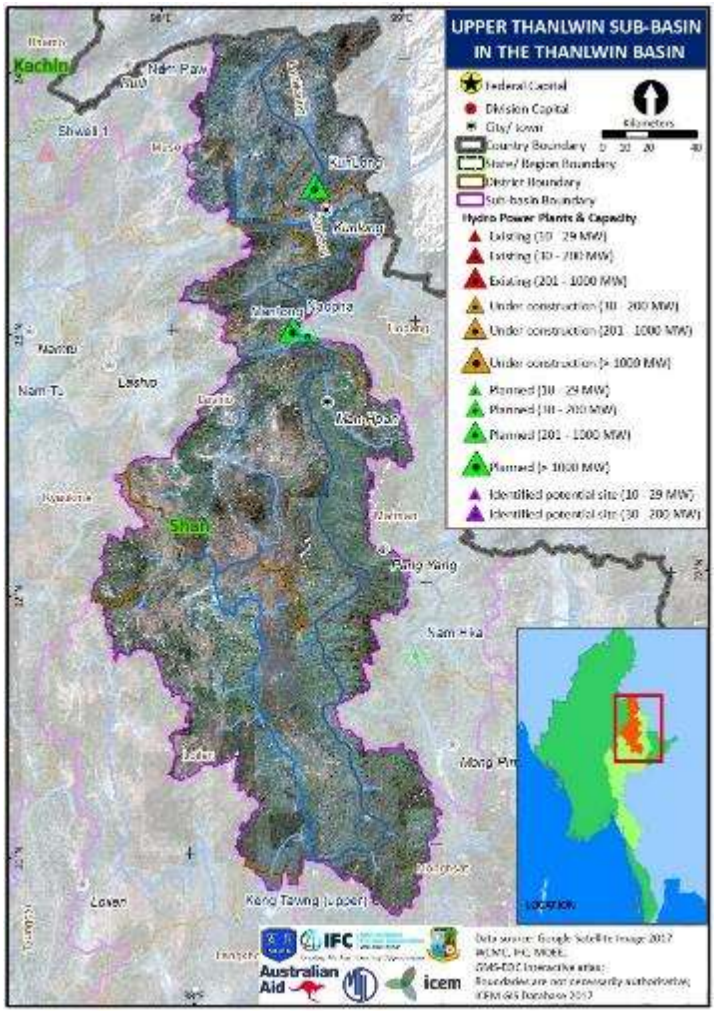
- Sub-basin heavily influenced by ceasefire armed group KNU (medium)
- Eight estimated battle deaths 1989-2015 (very low)
- Six 2012-2016 media-reported armed conflict incidents (high)
- 18,452 estimated historical conflict-related displaced people (very high)

4.7.7 Thanlwin Upper

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
5	2	1	2	5

Overview



Thanlwin Upper is the third largest sub-basin in the country and falls within the Shan state in the eastern region of Myanmar. It shares a border with China.

Area: 29,352 km^2

Average rainfall: 1,446 mm

Average sub-basin outflow: 2368.9 m^3/s

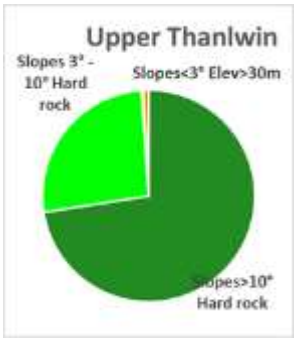
Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	26%
Slopes 3-10 soft rock	0%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	1%
Slopes>10 hard rock	73%
Slopes>10 intermed rock	0%

Socio-economic	Population: 1,122,780 Ethnic diversity: Chinese (Han), Kachins (Singpho), Lahu, Lisu, Palaung, Shan, Wa (Kawa) Economic activities: + Mining area: 2.9 km^2 (covers 0.01% of sub-basin) + Navigable waterways: None + Land use: Plantation (1.8%); Agriculture-Rainfed-Single (14.7%), Irrigated – Double (0.1%)
Administrative:	States/Regions: Shan Major town/s: Kunlong, Nam Hpan

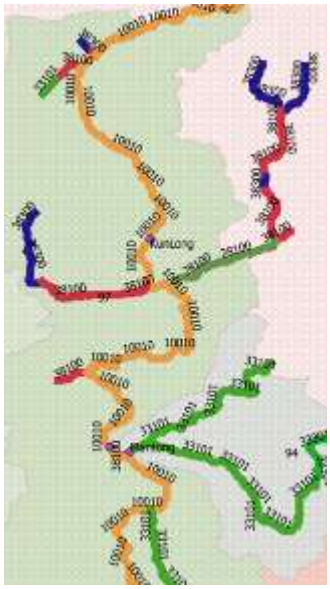
Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 2 (Kun Long – 1,400 MW, Naopha – 1,200 MW) Identified potential site: 0

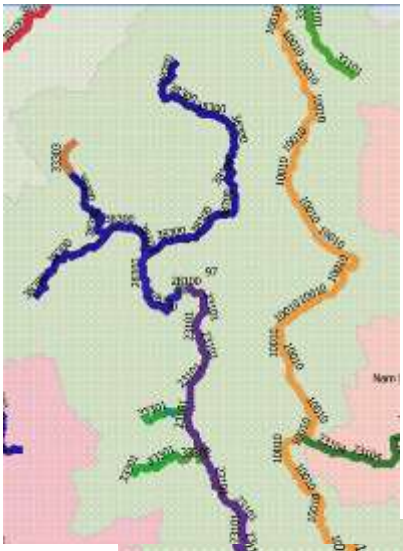
Geomorphology and sediment	Rating	5



- The Thanlwin Upper is a very large (96th percentile) catchment on th Shan Plateau and includes numerous tributaries flowing into the Thanlwin ranging up to Strahler Order 3;
- There are no existing hydropower projects in the sub-basin, or on the mainstem in China upstream;
- Deforestation and forestry plantations are evident in satellite photos and may have altered sediment inputs, but this is not considered in the evaluation;
- Overall the high connectivity, high inflow and potential sediment scores result in a very high geomorphology rating for the sub-basin;
- NOTE: this sub-basin does not include the mainstem Thanlwin which is considered as a separate unit with a geomorphology rating of 5

Aquatic ecology and fisheries	Ecological Value rating	3
	Human Pressure rating	2

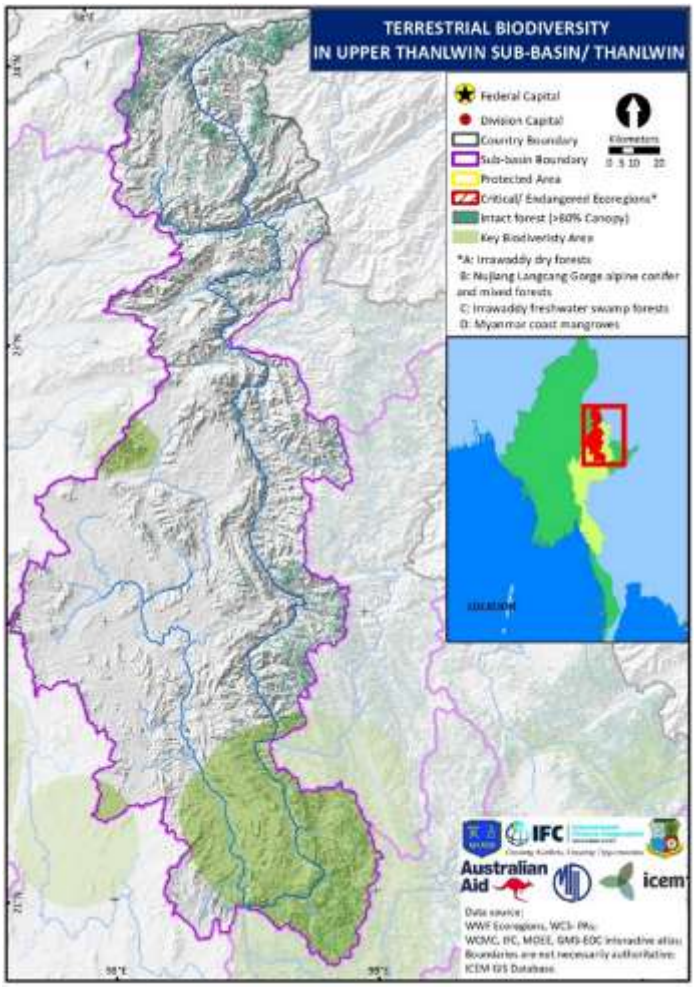




- The Thanlwin Upper extends for 644 km of rock cut mainstem channel from the Chinese border to the confluence with the Nam Pang. The sub-basin has two small tributaries on the left bank, including the Nam Hka, described separately, and one large tributary on the right bank, Nam Pang.
- The sub-basin contains 12 river reach types of which 7 are rare, making up 31% of all the reach lengths with 41% of the reaches flowing through karst region.
- The mean annual flows at the border with China is 1,689 m^3/sec with a minimum flow of 292 m^3/sec. At the lower end of the sub-basin, the mean annual flows are 2368 m^3/sec with a contribution from the Nam Pang of 225 m^3/sec.
- The upper Thanlwin reaches are reported to have relatively low fish diversity, but this may be due to the absence of surveys.
- The lower reaches of the Nam Pang consist of the rare Large river, in moist broadleaf forest region at low elevation, with low gradient, but higher up it flows through karst region at high elevation. The Nam Pang has some unique geomorphological features – a series of rapids and waterfalls in the lower end, and braided channel with islands and in-channel wetlands extending for many kilometres upstream.
- There are no riverine KBAs identified in the sub-basin, though the Nam San mountain range KBA is reported to be important for turtles and tortoises.
- Human pressures in this sub basin are low with low population densities, very low agricultural intensity, low mining and good forest cover.
- There are two very large hydropower plants planned on the Upper Thanlwin – Nao Pha (1,200 MW) and Kun Long (1,400 MW)

- Note: The Ecological Value rating is for the tributaries only, not for mainstem reaches

Terrestrial Biodiversity	Rating	1



The Thanlwin Upper sub-basin is not very biodiverse with 19% KBA and only 7% intact forest. The KBA in the sub-basin is a habitat for several aquatic species including turtles and various endemic fish species.

Social, livelihoods, and significant sites	Rating	2

In the Thanlwin Upper sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 31% of the workforce. Female-headed households, which indicate social vulnerability accounts for 20% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 50%. The ethnic minority groups in the sub-basin are Chinese (Han), Kachins (Singpho), Lahu, Lisu, Palaung, Shan and Wa (Kawa). On this basis, the sub-basin vulnerability rating is 4.

Conflict	Rating	5

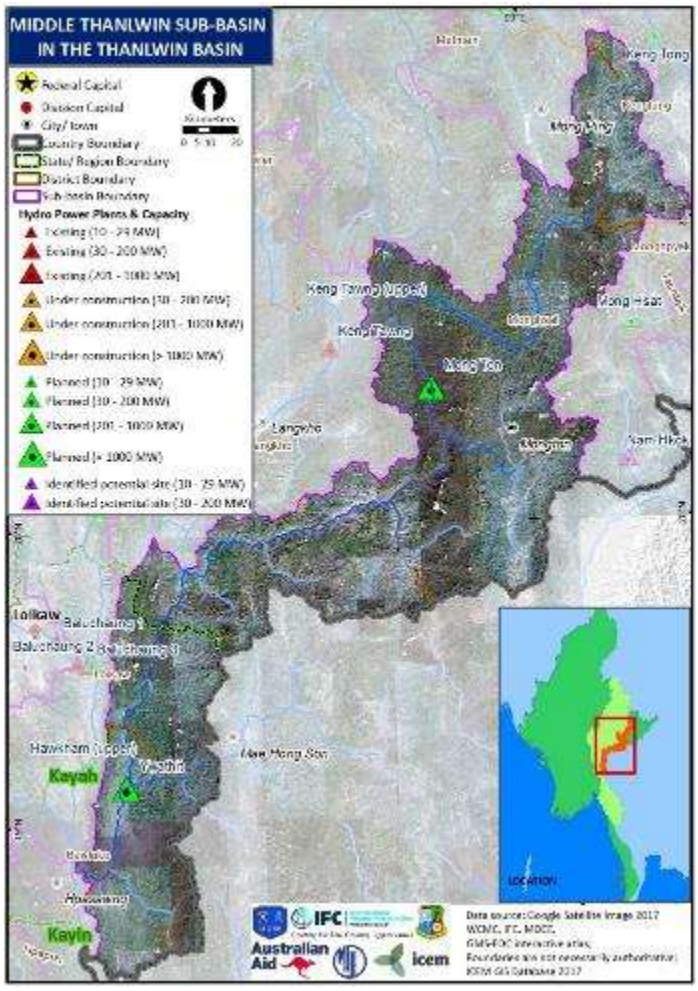
- Multiple armed groups actively contesting the Myanmar Army (high)
- 660 estimated battle deaths 1989-2015 (very high)
- 209 2012-2016 media-reported armed conflict incidents (very high)
- 26,468 estimated historical conflict-related displaced people (very high)

4.7.8 Thanlwin Middle

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
5	4	3	4	4

Overview



Thanlwin Middle is one of the larger sub-basin and spans several states in the southeastern region of the main body of Myanmar that borders Thailand.

Area: 20,264 km^2

Average rainfall: 1,264 mm

Average sub-basin outflow: 3381 m^3/s

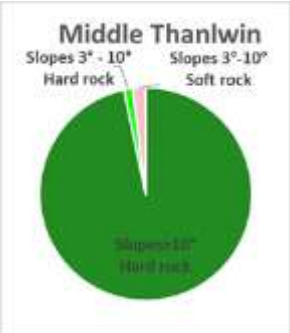
Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	1%
Slopes 3-10 soft rock	2%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	97%
Slopes>10 intermed rock	0%

Socio-economic	Population: 134,457 Ethnic diversity: Karen, Kayah, Lao, Shan Economic activities: + Mining area: 0.9 km^2 + Navigable waterways: None + Land use: Plantation (0.2%); Agriculture-Rainfed-Single (2.2%), Irrigated – Double (0.1%)
Administrative:	States/Regions: Kayah, Shan Major town/s: Mongton
Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 2 (Mong Ton – 7,000 MW, Ywathit – 4,000 MW) Identified potential site: 0

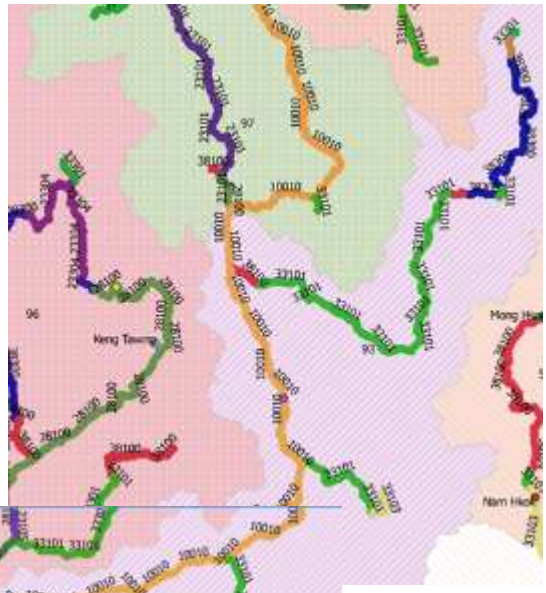
Geomorphology and sediment	Rating	5

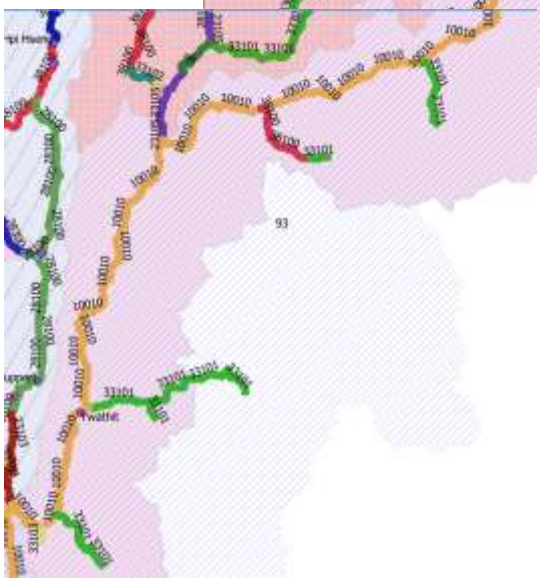
- The Thanlwin Middle is a very large sub-basin (84th percentile) that consists of steep mounts and contains high Strahler Order (3) tributaries of the mainstem Thanlwin;
- The catchment is largely undeveloped and there is no flow regulation in any of the water sheds within this sub-basin;
- The steep, crystalline mountains have high sediment production potential and over all this sub-basin is considered to have a very high geomorphology rating;
- NOTE: this sub-basin does not include the mainstem Thanlwin which is considered as a separate unit with a geomorphology rating of 5.



Aquatic ecology and fisheries	Ecological Value rating	4
	Human Pressure rating	1

- The Thanlwin Middle sub-basin starts at the confluence of the Nam Pang and the Thanlwin mainstem and extends for 377 km of rock cut channel to the confluence with the Nam Pawn. Over this length the middle Thanlwin sub-basin is very narrow with few tributaries entering, so that there are only medium sized rivers contributing to the flow.
- There are 6 medium river reach types of which 4 are rare, but making up only 9% of the lengths and with 26% of the reaches flowing through karst region, at both low and high elevation. The predominant river reach type is Medium river, in moist broadleaf forest region at low elevation, with low gradient. These reaches are mostly located in a left bank tributary that joins shortly after the Nam Pang,
- The mean annual flows in the middle Thanlwin start at 2,597 m^3/sec and exit the m^3/sec with a minimum m^3/sec.
- The middle Thanlwin, is an migration route for fish, Hilsa.
- The whole of the sub-basin mainly terrestrial Thanlwin KBA
- Human pressures are limited with low rural population agriculture and mining
- There are no hydropower present, although two large proposed at Ywathit (4,000 upstream from the Nam and Mong Ton (7,000 MW) which is 60 km downstream from the Nam Pawng confluence.





sub-basin at 3,381 flow of 603

important including the

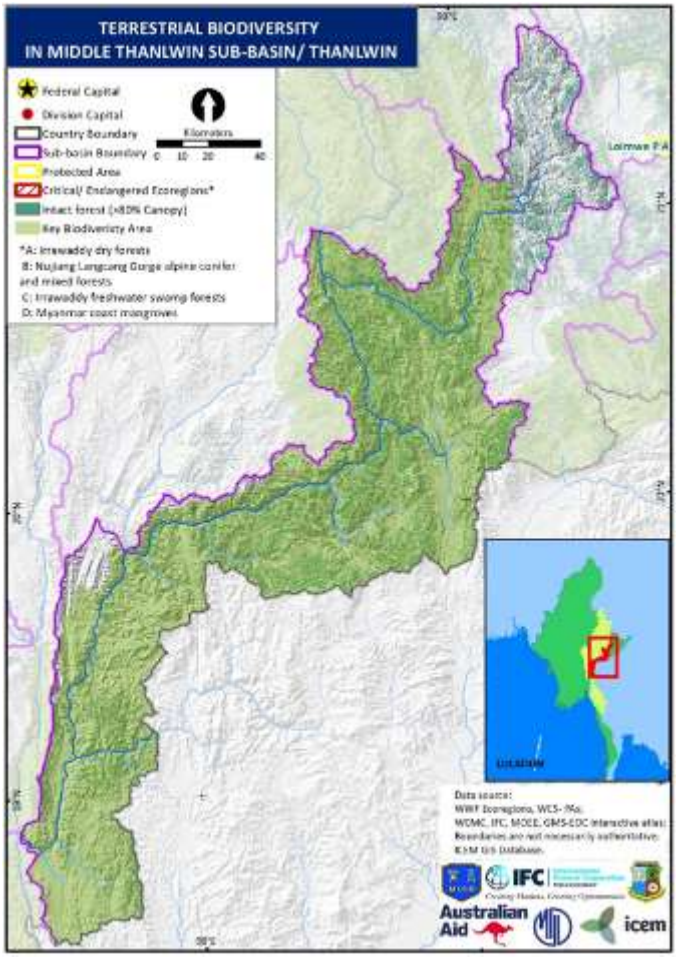
lies within the southern forest

in this sub-basin, densities, limited activities.

projects at projects are MW) 57 kms Pawn confluence,

Note: The Ecological Value rating is for the tributaries only, not for mainstem reaches

Terrestrial Biodiversity	Rating	3



The Thanlwin Middle sub-basin is composed of nearly 85% KBA including the Golden Triangle Area, an important habitat for several species of aquatic plants and vulnerable species of dragon flies. Due to the comparably low intact forest cover (17%), this sub-basin receives a biodiversity rating of 3.

Social, livelihoods, and significant sites	Rating	4

In the Thanlwin Middle sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 35% of the workforce. Female-headed households, which indicate social vulnerability accounts for 19% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 42%. The ethnic minority groups in the sub-basin are Karen, Kayah, Lao and Shan. On this basis, the sub-basin vulnerability rating is 4.

Conflict	Rating	4

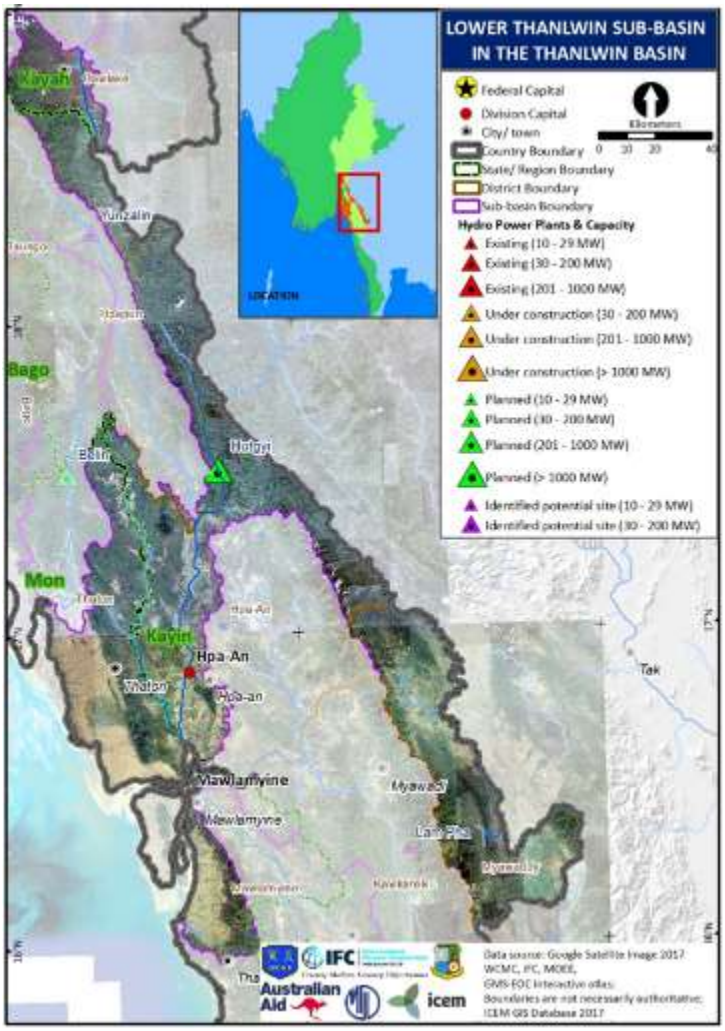
- Much of sub-basin influenced by multiple armed groups (high)
- 82 estimated battle deaths 1989-2015 (medium)
- 12 2012-2016 media-reported armed conflict incidents (very high)
- 49,557 estimated historical conflict-related displaced people (very high)

4.7.9 Thanlwin Lower

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
3	4	3	1	4

Overview



Lower Thanlwin is a medium sized sub-basin that spans multiple states in the southern branch of Myanmar that borders Thailand.

Area: 13,972 km^2

Average rainfall: 2,990 mm

Average sub-basin outflow: 5-93.8 m^3/s

Topography:

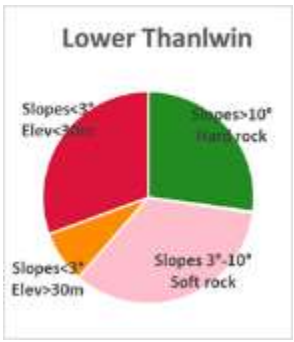
Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	34%
Slopes<3 Elev<30m	31%
Slopes<3 Elev>30m	8%
Slopes>10 hard rock	27%
Slopes>10 intermed rock	0%

Socio-economic	Population: 1,716,525 Ethnic diversity: Karen, Kayah, Mon (Talaing) Economic activities: + Mining area: 2.9 km^2 (covers 0.02% of sub-basin) + Navigable waterways: 87.7 km + Land use: Plantation (0.7%); Agriculture-Rainfed-Single (4.6%), Flood Plain – Single (0.2%), Irrigated-Single (7.2%), Irrigated – Double (3.5%), Irrigated-Triple (0.2%)
Administrative:	States/Regions: Kayah, Kayin, Mon Major town/s: Hpasawng, Thanbyuzayat, Thaton

Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 1 (Hutgyi – 1,360 MW) Identified potential site: 0

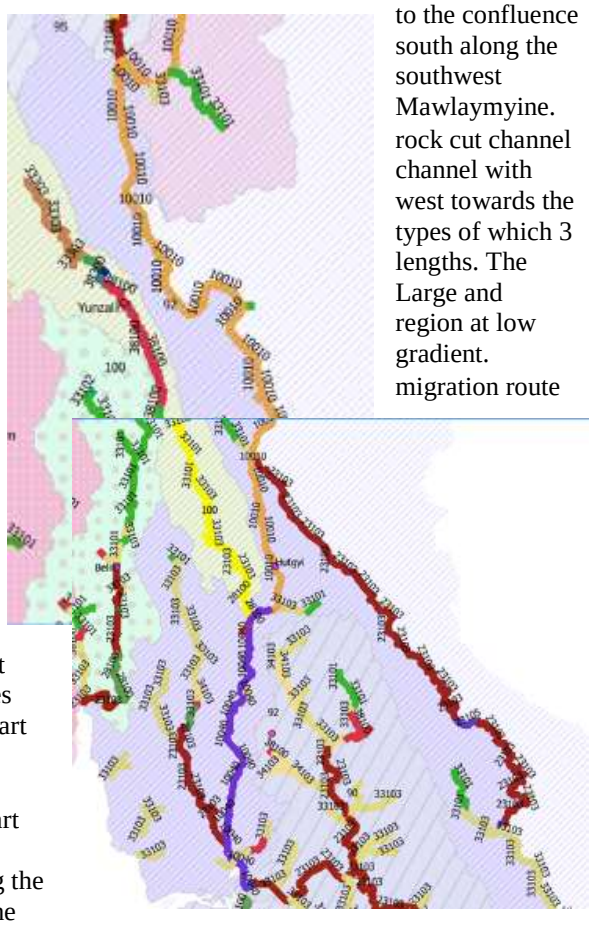
Geomorphology and sediment	Rating	3

- The Thanlwin Lower is a medium sized basin (67th percentile) that consists of a number of small, Strahler Order 1 tributaries flowing into the mainstem Thanlwin;
- The sub-basin is highly varied, as it encompasses the area where the Thanlwin emerges from the mountains and flows through the coastal plain;
- Rainfall is high and connectivity is not disrupted by any hydropower developments within the catchment;
- The medium geomorphology rating is attributable to the low Strahler Order and low sediment input potential.
- NOTE: this sub-basin does not include the mainstem Thanlwin which is considered as a separate unit with a very high geomorphology rating (5).

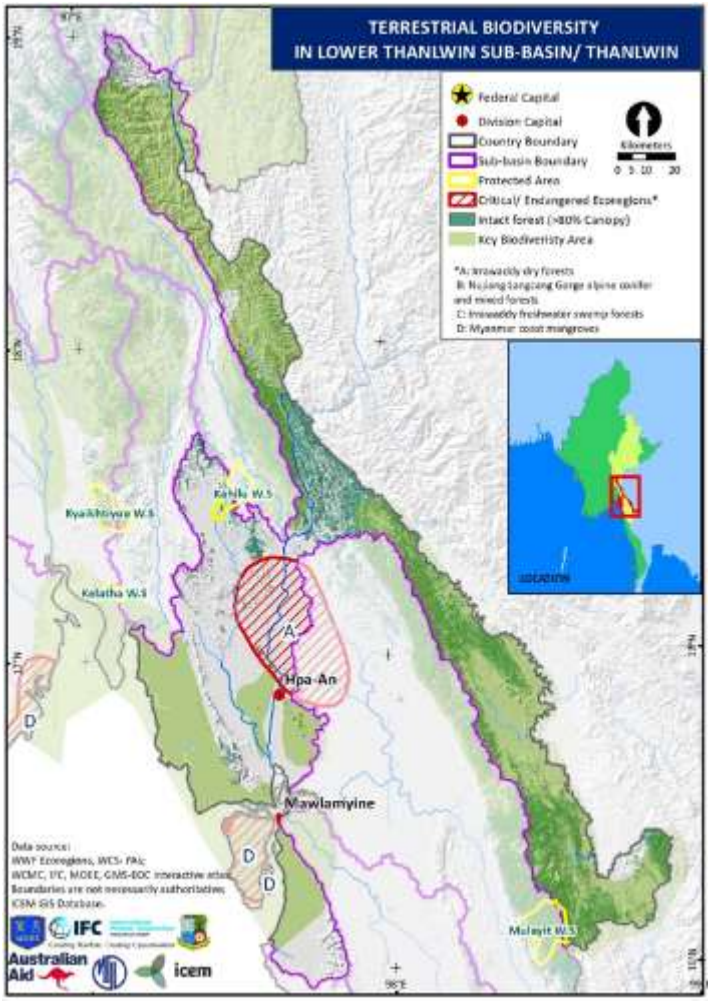


Aquatic ecology and fisheries	Ecological Value rating	4
	Human Pressure rating	2

- The Thanlwin Lower sub-basin is a complex basin consisting of the narrow Thanlwin valley starting at the Nam Pawn confluence, downstream to the confluence with the Moei river flowing in from the south along the border with Thailand and thence in a southwest direction towards the estuary at Mawlaymyine.
- Most of the Thanlwin mainstem flows in a rock cut channel (227 km), which changes to a meandering channel with alluvium (113 km) as it starts to flow south west towards the sea. The sub-basin contains 9 river reach types of which 3 are rare, representing 14% of the reach lengths. The predominant reach types are the common Large and medium rivers, in moist broadleaf forest region at low elevation, with floodplains and at low gradient.
- The Thanlwin mainstem is an important migration route for fish, including the smaller hilsa species. The Moei river also contains endemic and threatened mollusc and aquatic insect species and the Dawna Range KBA along this river is also important for the big-headed turtle.
- The upper part of the sub-basin would form part of the Thanlwin Peace Park KBA, and the lower floodplain and estuary contains karst limestone outcrops with important cave species that form KBAs. The estuary of Thanlwin is part of the Gulf of Mottama KBA.
- The upper part of the sub-basin is relatively sparsely populated, while the lower alluvial part has high population densities and is intensely cultivated. There are several large towns along the lower Thanlwin, contributing to pollution in the lower reaches.
- Note: The Ecological Value rating is for the tributaries only, not for mainstem reaches



Terrestrial Biodiversity	Rating	3



The Thanlwin Lower sub-basin is notably biodiverse because 62% of the sub-basin area is composed of KBA that is home to a wide variety of fauna such as sand pipers, turtles, bats, tigers, and more. Only 17% of the sub-basin is composed of intact forest, but another 9% contained Irrawaddy dry forests (6%) and coastal mangrove forests (3%) before human development started to weaken these ecoregions.

Social, livelihoods, and significant sites	Rating	1

In the Thanlwin Lower sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 18% of the workforce. Female-headed households, which indicate social vulnerability accounts for 27% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 62%. The ethnic minority groups in the sub-basin are Karen, Kayah and Mon (Talaing). On this basis, the sub-basin vulnerability rating is 1.

Conflict	Rating	**4**

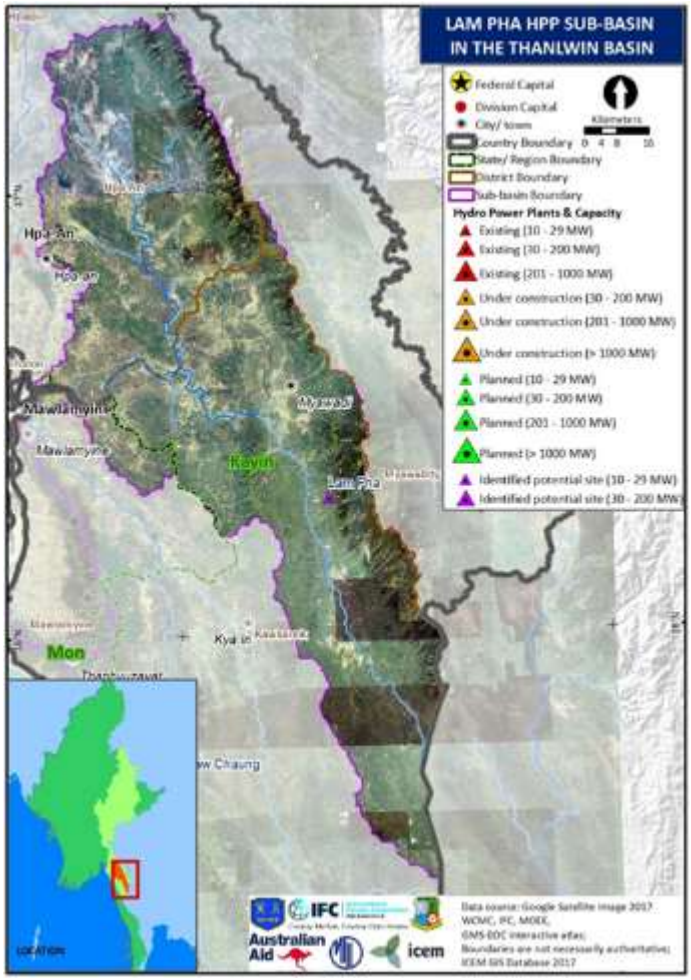
- Some of sub-basin influenced by multiple, sometimes competing armed groups (medium)
- 449 estimated battle deaths 1989-2015 (very high)
- 18 2012-2016 media-reported armed conflict incidents (very high)
- 23,706 estimated historical conflict-related displaced people (very high)

4.7.10 Lam Pha

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
2	3	1	4	4

Overview



Lam Pha is a medium-sized sub-basin located in the Kayin and Mon states in the southeastern branch of Myanmar that borders Thailand.

Area: 8,910 km^2

Average rainfall: 3,137 mm

Average sub-basin outflow: 660 m^3/s

Topography:

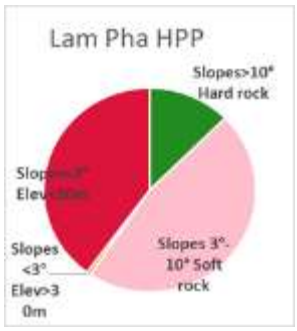
Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	47%
Slopes<3 Elev<30m	40%
Slopes<3 Elev>30m	1%
Slopes>10 hard rock	13%
Slopes>10 intermed rock	0%

Socio-economic	Population: 486,225 Ethnic diversity: Karen, Mon (Talaing) Economic activities: + Mining area: No + Navigable waterways: 4 km + Land use: N/A
Administrative:	States/Regions: Kayin, Mon Major town/s: Hpa-an, Myawadi

Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 0 Identified potential site: 1 (Lam Pha – 19.5 MW)

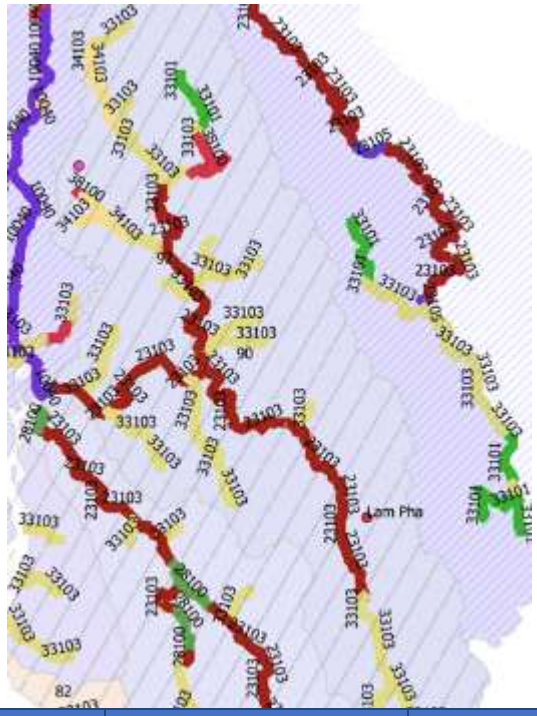
Geomorphology and sediment	Rating	2 (3)

- Lam Pha sub-basin is a medium sized (49th percentile) catchment with a Strahler Order 3 mainstem that discharges in the same coastal area as the Thanlwin and the Myet Taw Chaung sub-basin;
- The river network is structurally controlled, trending north south as it flows between the ridges;
- Rainfall is moderate in the catchment, and much of the catchment is occupied by flat lying coastal deposits;
- The geomorphology rating reflects the size of the basin, moderate rainfall and relatively low sediment generation from "hard" geology types.

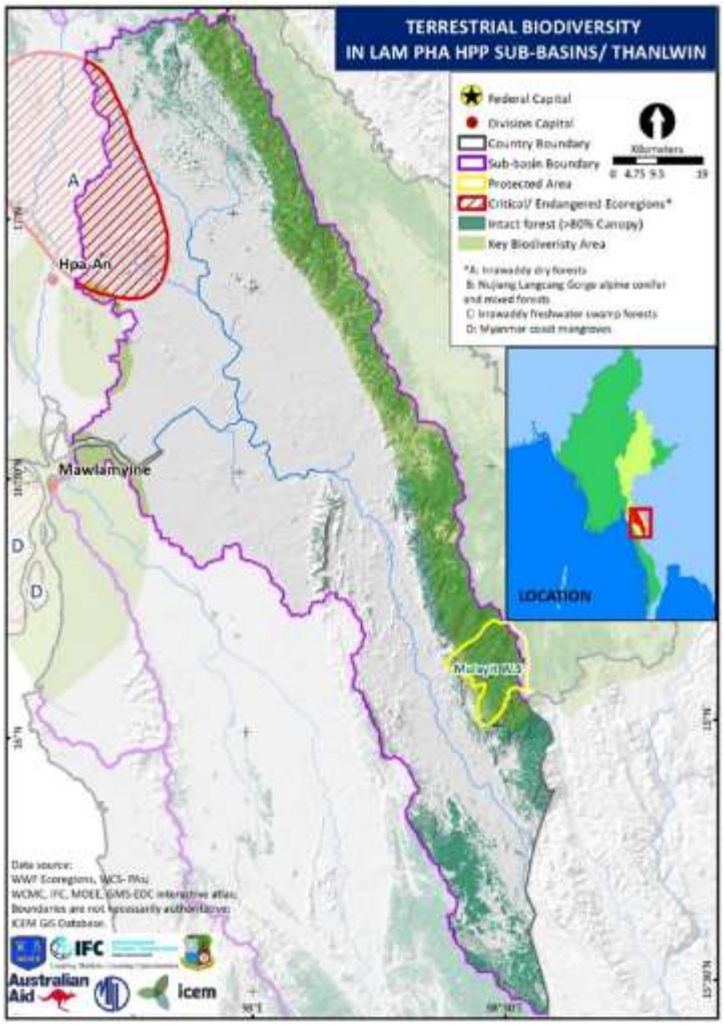


Aquatic ecology and fisheries	Ecological Value rating	3
	Human Pressure rating	3

- The Gyaing River meets the Thanlwin river at Mawlamyine. It has two branches one from the north, running parallel to the Thanlwin and one flowing in from the south (Haungthayaw River). The river has 5 river reach types of which one is rare with 9% of the reach lengths, and a small proportion (8%) of reaches in karst regions at low elevation. The main reach types are Large and medium rivers, in moist broadleaf forest region at low elevation, with floodplains.
- The mean annual flow at the confluence with the Thanlwin is 668 m^3/sec with a minimum flow of 63 m^3/sec
- The river has the presence of threatened fish and aquatic plants and insects, raising its ecological value
- Human pressures are moderate, with moderate rural population density, and agricultural intensity and little mining activity. There is a large urban population of about 500,000 at Mawlamyine, which will affect water quality in the estuary.
- One hydropower dam is planned high up in the southern catchment – Lam Pha HPP (19.5 MW).



Terrestrial Biodiversity	Rating	1



The Lam Pha sub-basin contains moderate KBA (19%) and intact forest (18%) cover. The KBA is home to numerous species of mammals including elephants, tigers, bats, and more. Although small (2%), the Mulayit Wildlife sanctuary is located in this sub-basin as well. Another 6% of the basin was at least in the past composed of the critically endangered Irrawaddy dry forests ecoregion, although it has been degraded recently due to human influence.

Social, livelihoods, and significant sites	Rating	4

In the Lam Pha sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 21% of the workforce. Female-headed households, which indicate social vulnerability accounts for 32% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 40%. The ethnic minority groups in the sub-basin are Karen and Mon (Talaing). On this basis, the sub-basin vulnerability rating is 4.

Conflict	Rating	4

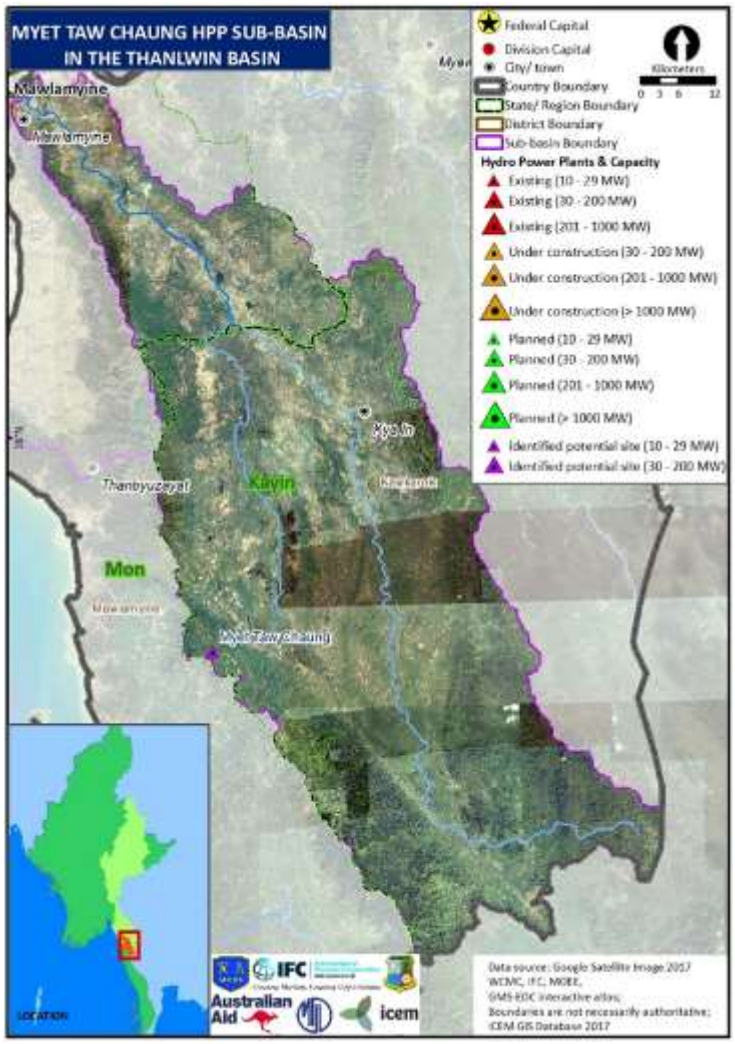
- Multiple ceasefire and non-ceasefire armed groups are influential in the sub-basin (high)
- 14 estimated battle deaths 1989-2015 (low)
- 28 2012-2016 media-reported armed conflict incidents (very high)
- 12,839 estimated historical conflict-related displaced people (very high)

4.7.11 Myet Taw Chaung

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
1	3	1	2	4

Overview



Myet Taw Chaung is a relatively small sub-basin that falls within the Kayin and Mon states in the southeastern branch of Myanmar that borders Thailand.

Area: 5,665 km^2

Average rainfall: 3,818 mm

Average sub-basin outflow: 502.01 m^3/s

Topography:

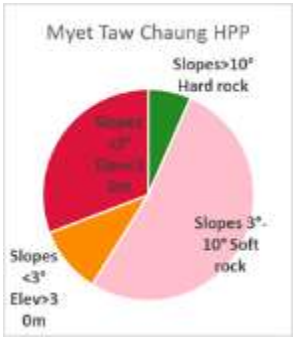
Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	52%
Slopes<3 Elev<30m	31%
Slopes<3 Elev>30m	10%
Slopes>10 hard rock	7%
Slopes>10 intermed rock	0%

Socio-economic	Population: 450,659 Ethnic diversity: Karen, Mon (Talaing) Economic activities: + Mining area: 1.7 km^2 (covers 0.03% of sub-basin) + Navigable waterways: None + Land use: N/A
Administrative:	States/Regions: Kayin, Mon Major town/s: Kya In, Mawlamyine

Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 0 Identified potential site: 1 (Myet Taw Chaung – 10 MW)

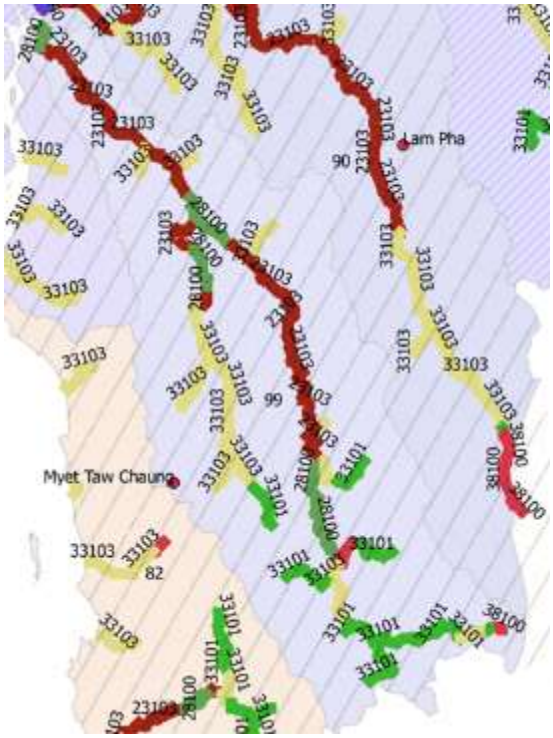
Geomorphology and sediment	Rating	1 (3)

- The Myet Taw Chaung is a small sub-basin (33rd percentile) that lies between the Thanlwin and the Tanintharyi, with the north south trending river confined by the structurally controlled valley;
- The lower reaches of the river are separated from the coastal plain by the hills south to Mawlamyine, where it joins the complex Thanlwin estuary;
- Rainfall is very high, but the low Strahler Order (2) and small area of the catchment, combined with a low sediment input potential result in a low overall rating;
- Similar to other small sub-basins identified for future hydropower development in this analysis, the rating of the individual sub-basin is likely lower than if it were combined with a larger neighbouring sub-basin.

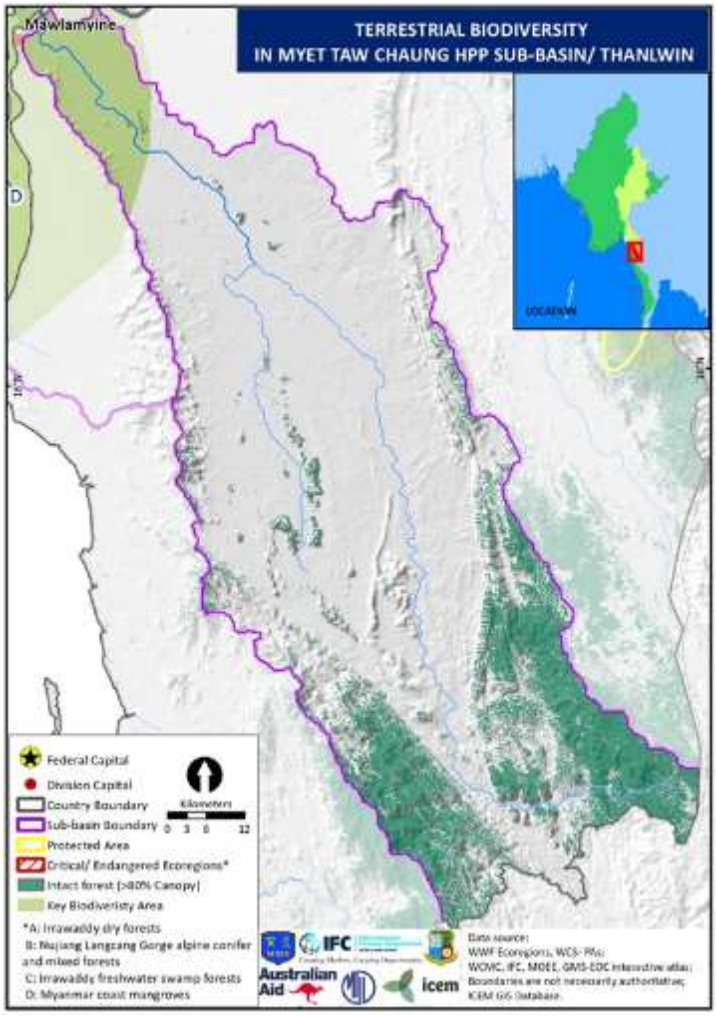


Aquatic ecology and fisheries	Ecological Value rating	3
	Human Pressure rating	3

- The Ataran river flows into the Thanlwin estuary at Mawlamyine from the south. It is a relatively small lowland river with 5 river reach types of which 1 is rare with just over 1% proportion of the reach lengths. There is 155 of the reach lengths in low elevation karst region. The main reach types are Large and medium river, in moist broadleaf forest region at low elevation, with floodplains and at low elevation.
- The mean annual flows at the confluence are 502 m3/sec with a very low minimum of 15 m3/sec.
- The river does have the presence of some threatened fish species, and discharges into the Gulf of Mottama KBA, important for water birds
- Human pressures are moderate, with moderate rural population density, and agricultural intensity and little mining activity. There is a large urban population of about 500,000 at Mawlamyine, which will affect water quality in the estuary.
- One hydropower plant is planned in the upper reaches of the Ataran river, Myet Taw Chaung HPP (10 MW)



Terrestrial Biodiversity	Rating	1



The Myet Taw Chaung sub-basin contains little KBA (6%) and intact forest (16%) cover and no protected areas or critically endangered ecoregions. The KBA is a habitat for the spoon-billed sand piper and the black-headed ibis.

Social, livelihoods, and significant sites	Rating	4

In the Myet Taw Chaung sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 22% of the workforce. Female-headed households, which indicate social vulnerability accounts for 24% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 48%. The ethnic minority groups in the sub-basin are Karen and Mon (Talaing). On this basis, the sub-basin vulnerability rating is 4.

Conflict	Rating	4

- Sub-basin is influenced by multiple armed groups (high)
- 28 estimated battle deaths 1989-2015 (medium)
- Three 2012-2016 media-reported armed conflict incidents (medium)
- 13,414 estimated historical conflict-related displaced people (very high)

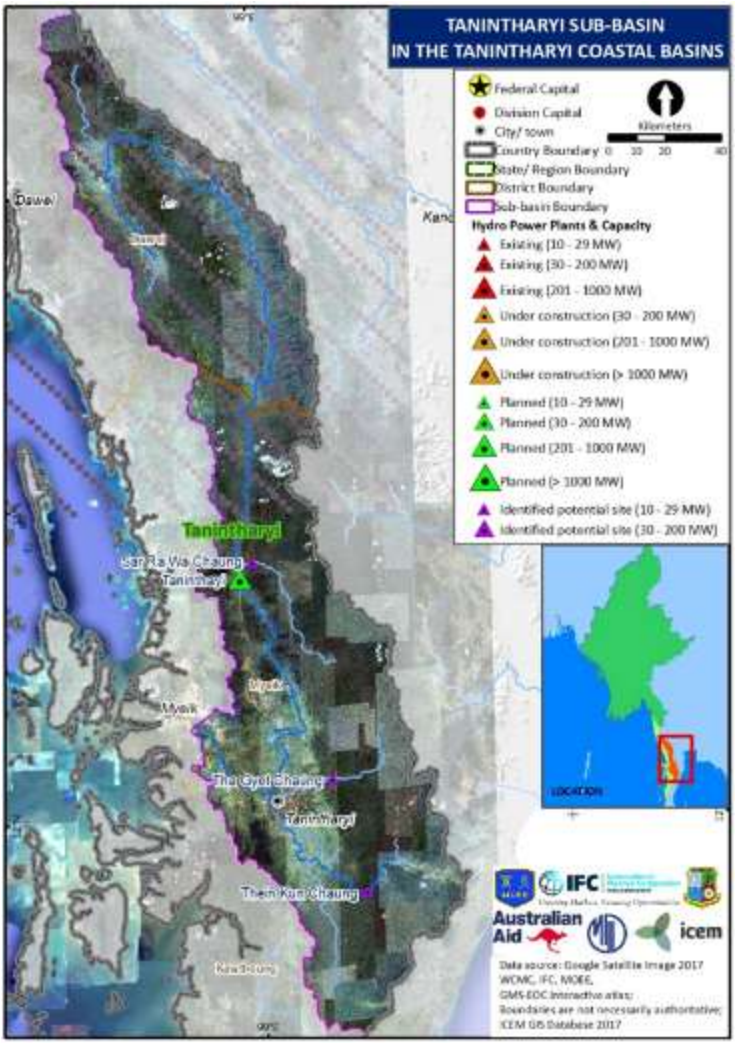
4.8 Tanintharyi Coastal Basins

4.8.1 Tanintharyi

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
5	5	5	4	4

Overview



Tanintharyi is a relatively large sub-basin that falls within the region of the same name in the southern branch of Myanmar and borders Thailand.

Area: 17,865 km^2

Average rainfall: 2,123 mm

Average sub-basin outflow: 910.6 m^3/s

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	25%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	75%
Slopes>10 intermed rock	0%

Socio-economic	Population: 253,817 Ethnic diversity: Karen, Siamese (Khon-Tai) Economic activities: + Mining area: 11.2 km^2 (covers 0.06% of sub-basin) + Navigable waterways: None + Land use: N/A
Administrative:	States/Regions: Tanintharyi Major town/s: Tanintharyi

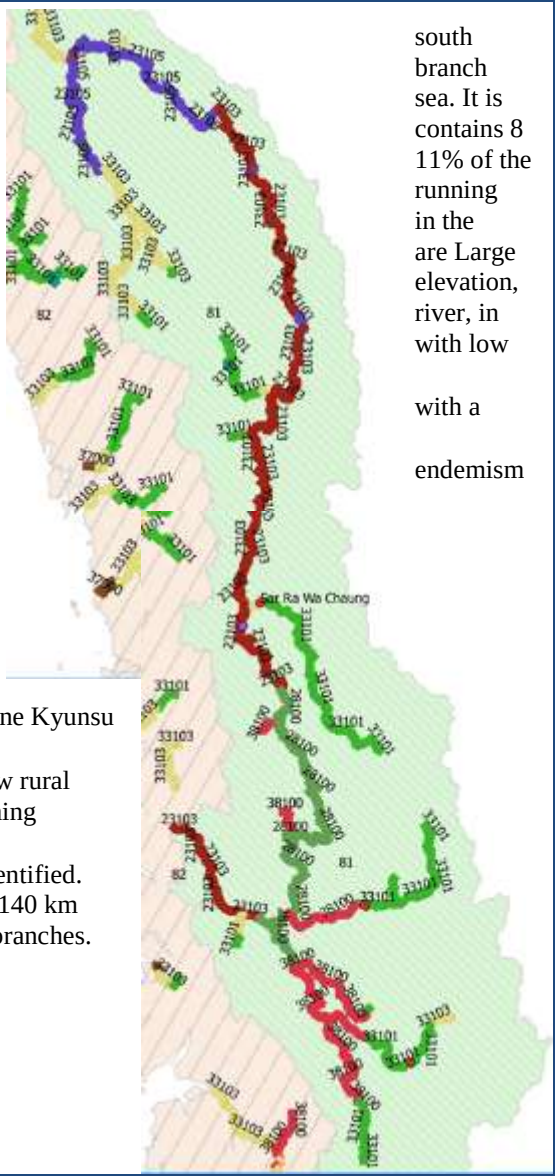
Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 1 (Tanintharyi – 600 MW) Identified potential site: 3 (Sar Ra Wa Chaung – 11 MW, Tha Gyet Chaung – 20 MW, Thein Kun Chaung – 25 MW)

Geomorphology and sediment	Rating	5

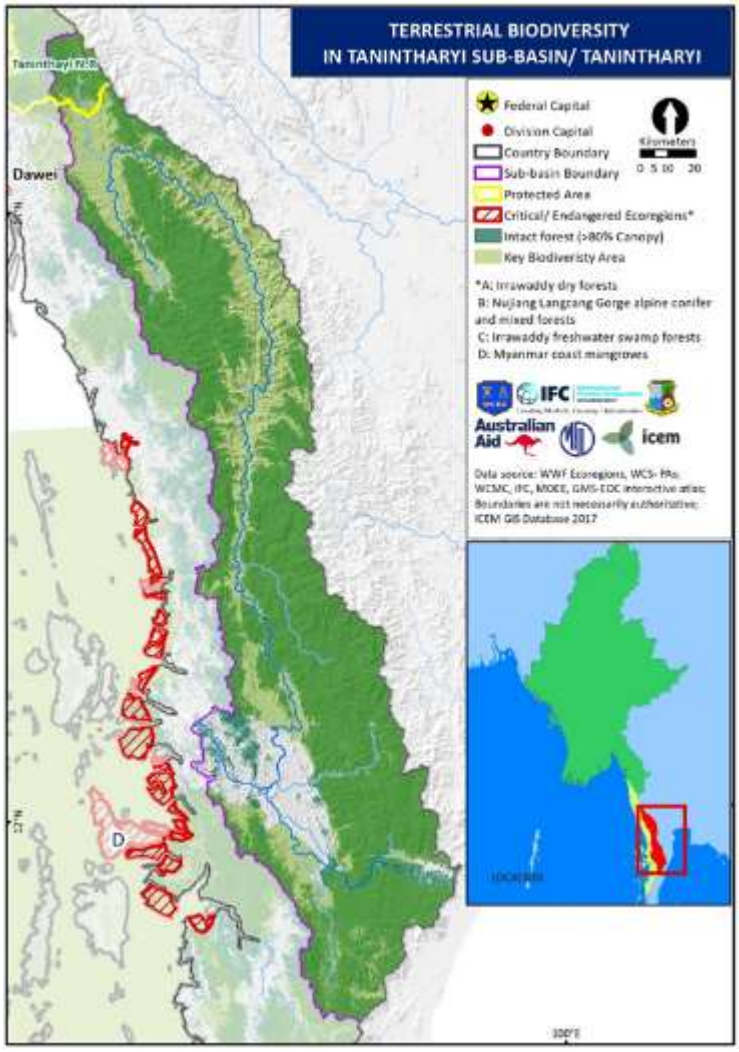
- The Tanintharyi River is a large sub-basin (77th percentile) that includes the elevated Tenasserim Hills along the border with Thailand;
- The river lies in ta north south trending narrow coastal zone and the sub-basin receives high rainfall and discharges directly to the sea;
- There is no existing hydropower in the sub-basin and the overall level of development is low;
- These characteristics contribute to a very high geomorphology rating.

Aquatic ecology and fisheries	Ecological Value rating	5
	Human Pressure rating	2

- The Tanintharyi river runs from the north to the south parallel to the coast, meeting with a smaller branch river from the south, before flowing west to the sea. It is confined to the east by steep hills. The sub-basin contains 8 river reach types of which 2 are rare, making up 11% of the reach length. It has 26% of the river reaches running through karst region at low elevation, especially in the southern branch. The predominant reach types are Large river, in moist broadleaf forest region at low elevation, with floodplains and with sediment, and Medium river, in moist broadleaf forest region at low elevation, with low gradient and with floodplains.
- The mean annual flow at the coast is 913 m^3/sec with a minimum flow of 93 m^3/sec.
- The river has been recognised as an area of endemism for aquatic species, including fish, with the presence of Endangered and Vulnerable fish species
- There are several terrestrial KBAs which cover the sub-basin, including the Tanintharyi national Park and Myinmoletkhat KBA. The river discharges into the larger marine Meyik Archipelago KBA and more locally into the estuarine Kyunsu KBA.
- Human pressures on the sub-basin are low, with low rural population, low agriculture intensity, moderate mining activity and good forest cover.
- One hydropower project is planned and 3 others identified. The Tanintharyi HPP (600 MW) would be located 140 km upstream of the confluence of the north and south branches.



Terrestrial Biodiversity	Rating	5



Almost 90% of the Tanintharyi sub-basin is composed of KBA that is an important corridor for tigers and elephants. It contains 64% intact forest and is a recognized forest conservation area. The Tanintharyi Nature Reserve is a protected area that composes nearly 3% of the sub-basin. It is one of only 6 out of 58 total sub-basins to receive a biodiversity rating of 5.

Social, livelihoods, and significant sites	Rating	4

In the Tanintharyi sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 24% of the workforce. Female-headed households, which indicate social vulnerability accounts for 40% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 49%. The ethnic minority groups in the sub-basin are Karen and Siamese (Khon – Tai). On this basis, the sub-basin vulnerability rating is 4.

Conflict	Rating	4

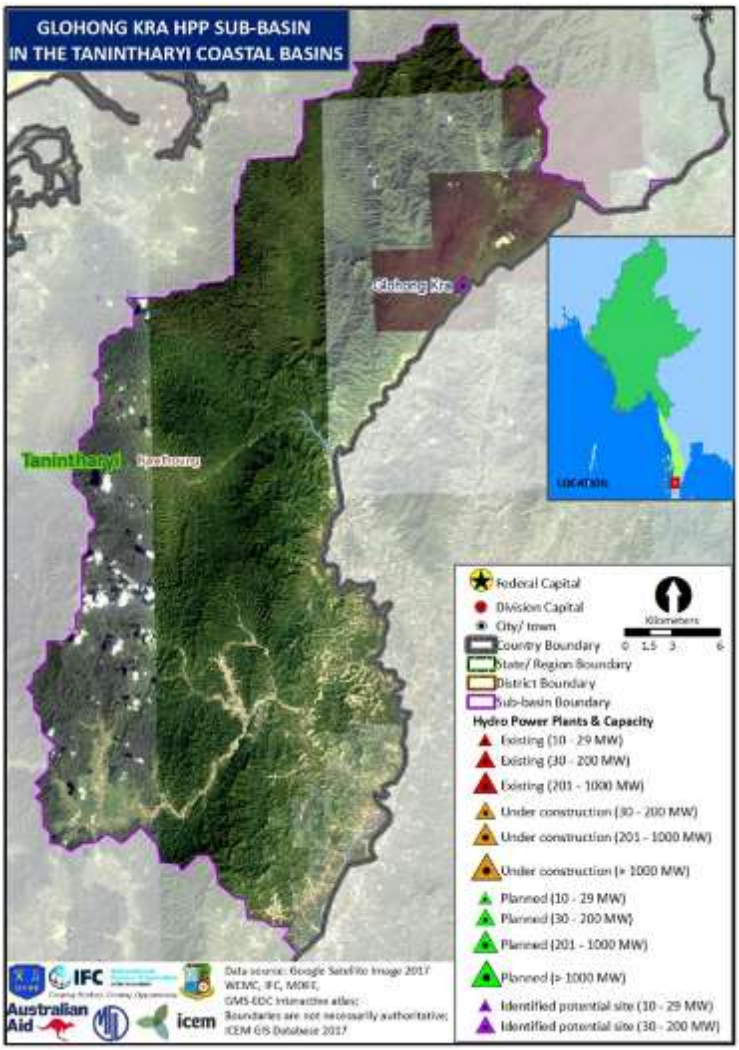
- Ceasefire armed group (KNU) influential in much of the sub-basin (medium)
- 70 estimated battle deaths 1989-2015 (medium)
- Two 2012-2016 media-reported armed conflict incidents (medium)
- 20,441 estimated historical conflict-related displaced people (very high)

4.8.2 Glohong Kra

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
1	3	4	1	2

Overview



Glohong Kra is the fourth largest sub-basin in the country and is in the Tanintharyi region in the southern tip of Myanmar.

Area: 992 km^2

Average rainfall: 2,942 mm

Average sub-basin outflow: 8.05 m^3/s

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	100%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	0%
Slopes>10 intermed rock	0%

Socio-economic	Population: 140,020 Ethnic diversity: Selung, Siamese (Khon-Tai) Economic activities: + Mining area: No + Navigable waterways: None + Land use: N/A
Administrative:	States/Regions: Tanintharyi Major town/s:

Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 0 Identified potential site: 1 (Glohong Kra – 40 MW)

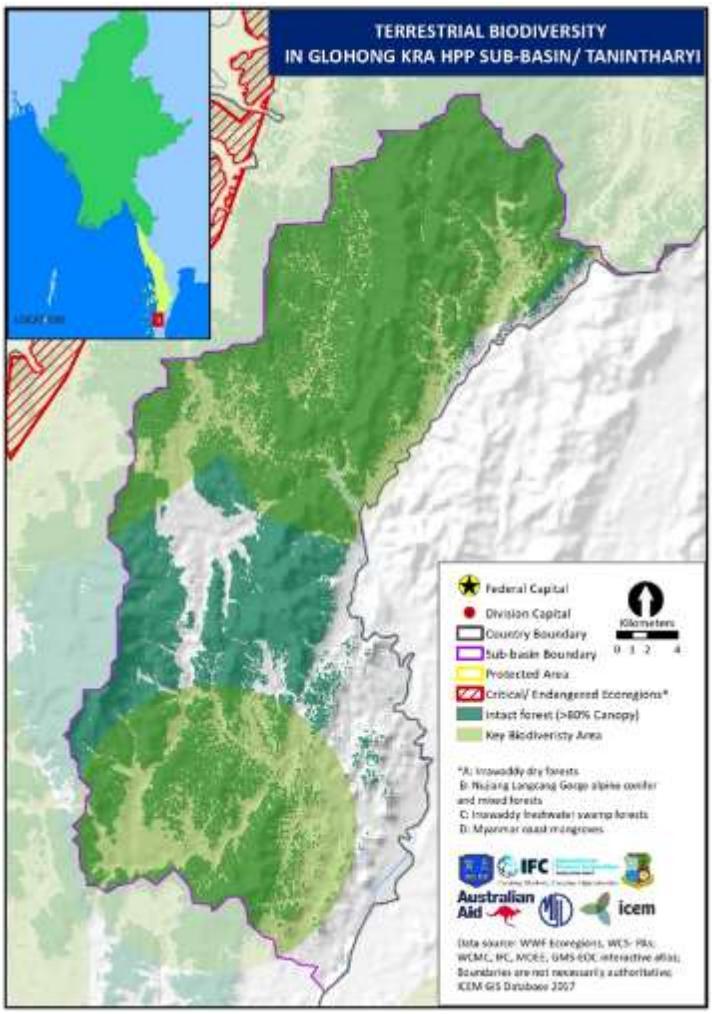
Geomorphology and sediment	Rating	1 (5)

- This very small (5th percentile) sub-basin is situated within the coastal hills and flows towards the south;
- It is undeveloped with respect to hydropower and receives high rainfall, but its small size restricts its connectivity rating to a 1 when compared to other basins;
- Sediment input is also considered to be relatively low, due to the underlying geology, although it may provide a locally important input to the coastal zone;
- Like other small sub-basins identified for potential hydropower development, the geomorphic rating is low due to the large scale, basin wide methodology adopted.

Aquatic ecology and fisheries	Ecological Value rating	3
	Human Pressure rating	3

- The sub-basin where the Glohong Kra HPP is proposed, is a sub-set of the Thanintharyi coastal sub-basin. It is located at the most southern end of the Myanmar coastal strip, and borders with Thailand.
- It contains about 70 km of Medium river, in moist broadleaf forest region at low elevation, with low gradient and with floodplains, both common river reach types.
- As it discharges into the Kra Buri creek that is the border with Thailand it has a mean annual flow of 85 m^3/sec with a minimum flow of 17 m^3/sec
- It is thought to contain some endemic species of fish and some threatened species of mollusc, reported from Thailand. The headwaters of this sub-basin have been identified as part of the Kara river KBA.
- Human pressures are moderate as with all the coastal strip – moderate rural population density and agriculture, with some loss of forest cover.
- One hydropower plant has been identified Glohong Kra HPP (40 MW).

Terrestrial Biodiversity	Rating	4



Although small, the Glohong Kra sub-basin is still important from a biodiversity standpoint. Over two thirds of the sub-basin is composed of KBA that is an important breeding ground for marine fauna, but is threatened by infrastructure and aquaculture development. Almost 62% is composed of intact forest.

Social, livelihoods, and significant sites	Rating	1

In the Glohong Kra sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 16% of the workforce. Female-headed households, which indicate social vulnerability accounts for 31% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 54%. The ethnic minority groups in the sub-basin are Selung and Siamese (Khon-Tai). On this basis, the sub-basin vulnerability rating is 1.

Conflict	Rating	2

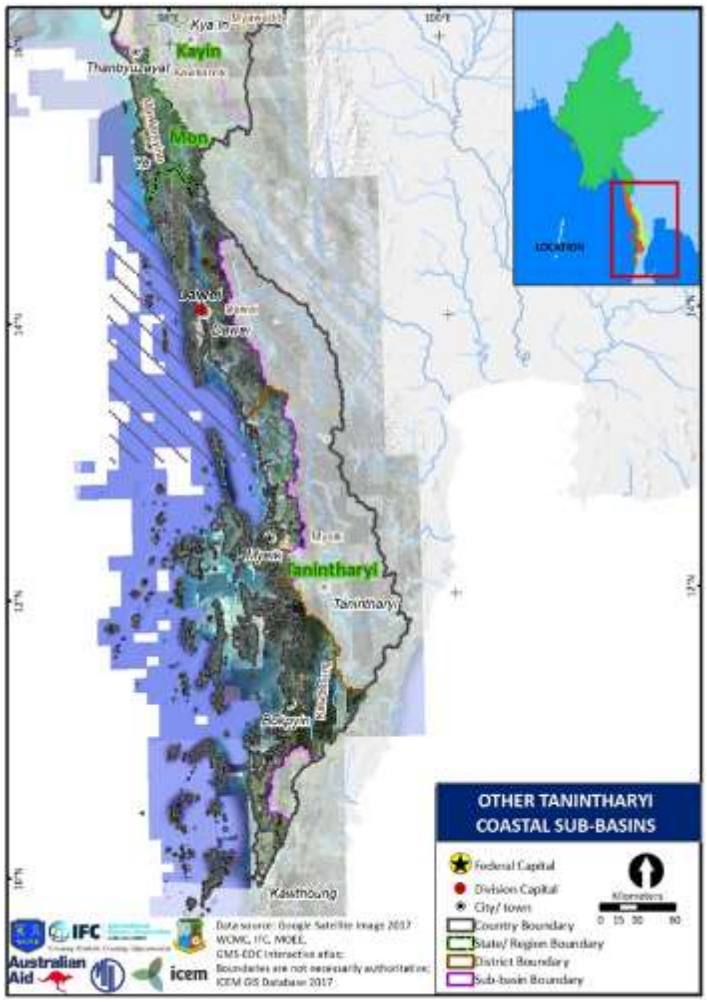
- Ceasefire armed group (KNU) influential in small parts of the sub-basin (medium)
- Zero estimated battle deaths 1989-2015 (very low)
- Zero 2012-2016 media-reported armed conflict incidents (very low)
- Four estimated historical conflict-related displaced people (very low)

4.8.3 Tanintharyi Coastal Basins Other

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
5	3	4	2	4

Overview



Other Tanintharyi is the 5th largest sub-basin and spans several states in the southern branch of Myanmar. It borders Thailand and outlets to the Andaman Sea.

Area: 26,019 km^2

Average rainfall: 3,615 mm

Average sub-basin outflow: 244.85 m^3/s

Topography:

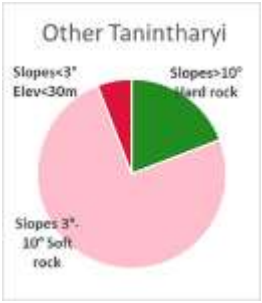
Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	75%
Slopes<3 Elev<30m	6%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	19%
Slopes>10 intermed rock	0%

Socio-economic	Population: 1,448,724 Ethnic diversity: Karen, Mon (Talaing), Selung Economic activities: + Mining area: 15.1 km^2 (covers 0.06% of sub-basin) + Navigable waterways: None + Land use: N/A
Administrative:	States/Regions: Kayin, Mon, Tanintharyi Major town/s: Bokpyin, Dawei, Kawthoung, Myeik, Ye

Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 0 Identified potential site: 0

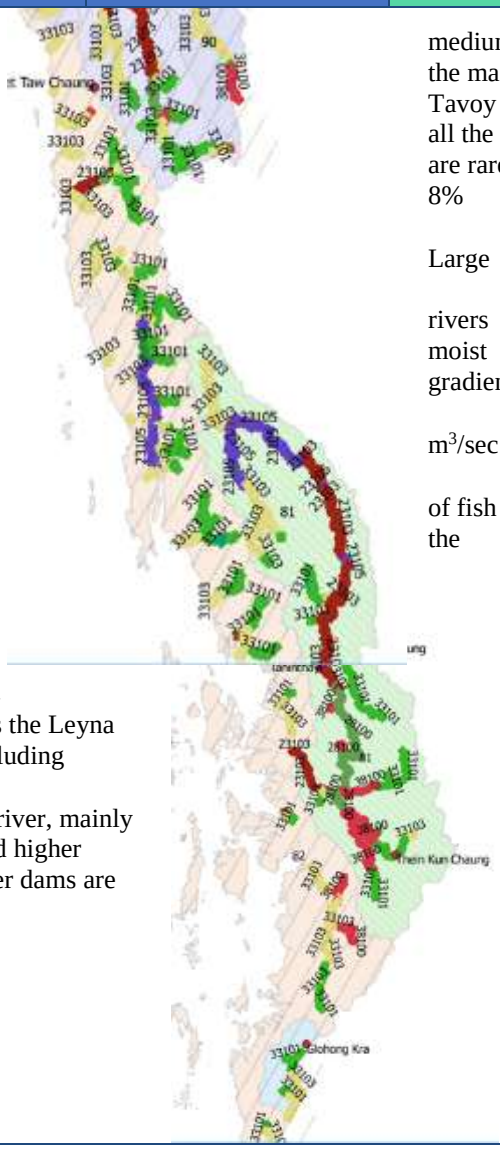
Geomorphology and sediment	Rating	5

- This "Other" Tanintharyi sub-basin is a very large area (93rd percentile) composed of a number of small tributaries that drain the coastal range and discharge directly to the sea;
- Although each individual catchment may be small, collectively they contribute the majority of the Tanintharyi "basin";
- The high rainfall results in high runoff, with moderate sediment loads projected;
- The undeveloped nature of the sub-basins, combined with large size and high rainfall result in a very high geomorphic rating.

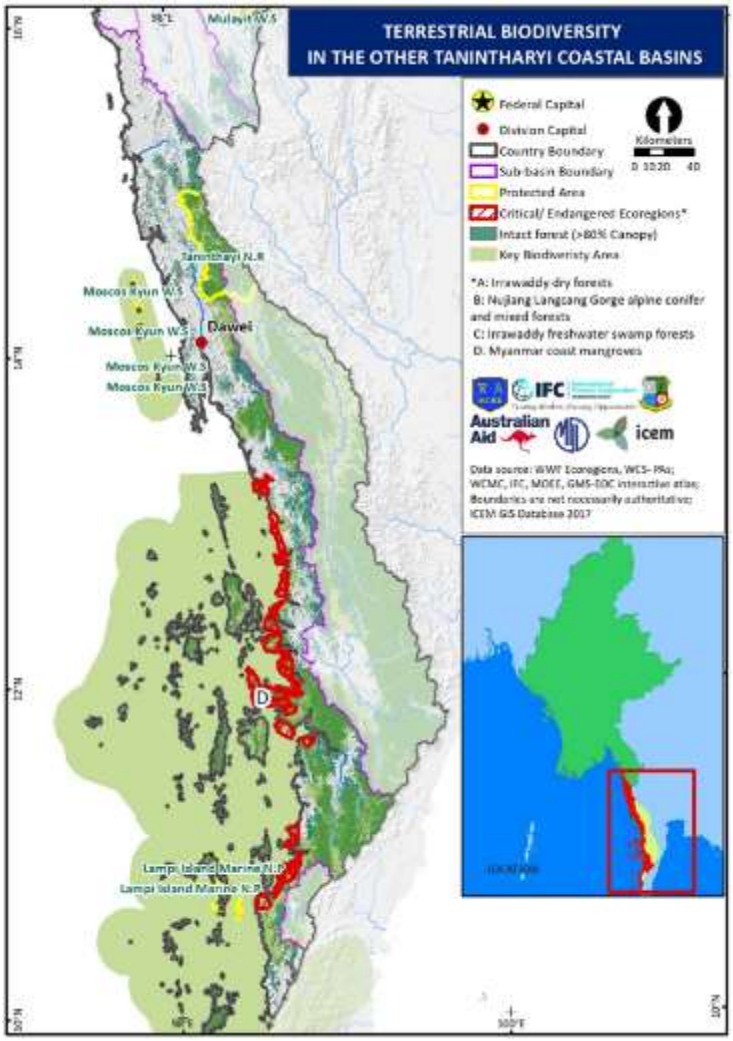


Aquatic ecology and fisheries	Ecological Value rating	3
	Human Pressure rating	3

- The Tanintharyi coastal basin rivers are short medium sized rivers rising in the ridge between the sea and the main Thanintharyi river valley. There is one large river, Tavoy discharging into its estuary at Dawei. Collectively all the coastal rivers have 10 river reach types of which 4 are rare covering about 7% of the reach lengths, and about 8% reaches in karst region at low elevation.
- The predominant reach type in the Tavoy river is Large river, in moist broadleaf forest region at low rivers elevation, with floodplains. Of the medium-sized moist the predominant reach types are Medium river, in gradient, broadleaf forest region at low elevation, with low and with floodplains.
- The mean annual flow from the Tavoy river is 345 m^3/sec with a minimum flow of 15 m^3/sec
- The Tavoy river contains some threatened species of fish and other aquatic organisms, but it is unlikely that the smaller rivers will contain such species. However, the rivers are discharging into an ecologically sensitive marine environment. These are recognised as coastal and mangrove KBAs including the Myeik Archipelago and Moscos Kyun.
- In the southern part one of the larger coastal rivers is the Leyna river, which is known to have high fish diversity including endemic species. The Leyna KBA reflects this.
- Human pressures are higher than in the Tanintharyi river, mainly because of population density in the coastal zone and higher agricultural activity and road density. No hydropower dams are planned in this coastal basin.



Terrestrial Biodiversity	Rating	4



The Tanintharyi other sub-basin contains 46% KBA and 45% intact forest. Similarly, to other large sub-basins, there are numerous KBAs that provide habitats for various species of birds, mammals, and aquatic flora and fauna including coral reefs, sharks, and dugongs. Three protected areas make up approximately 5% of the sub-basin: the Moscos Kyun Wildlife Sanctuary, the Lampi Island Marine National Park, and the Thanintharyi Nature Reserve. Another 5% of the sub-basin was composed of the critically endangered coastal mangrove ecoregion in the past as well.

Social, livelihoods, and significant sites	Rating	2

In the Tanintharyi Other Coastal sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 21% of the workforce. Female-headed households, which indicate social vulnerability accounts for 27% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 49%. The ethnic minority groups in the sub-basin are Karen, Mon (Talaing), and Selung. On this basis, the sub-basin vulnerability rating is 2.

Conflict	Rating	4

- Ceasefire armed group (KNU) influential in small parts of the sub-basin (low)
- 95 estimated battle deaths 1989-2015 (high)
- Five 2012-2016 media-reported armed conflict incidents (high)
- 86,576 estimated historical conflict-related displaced people (very high)

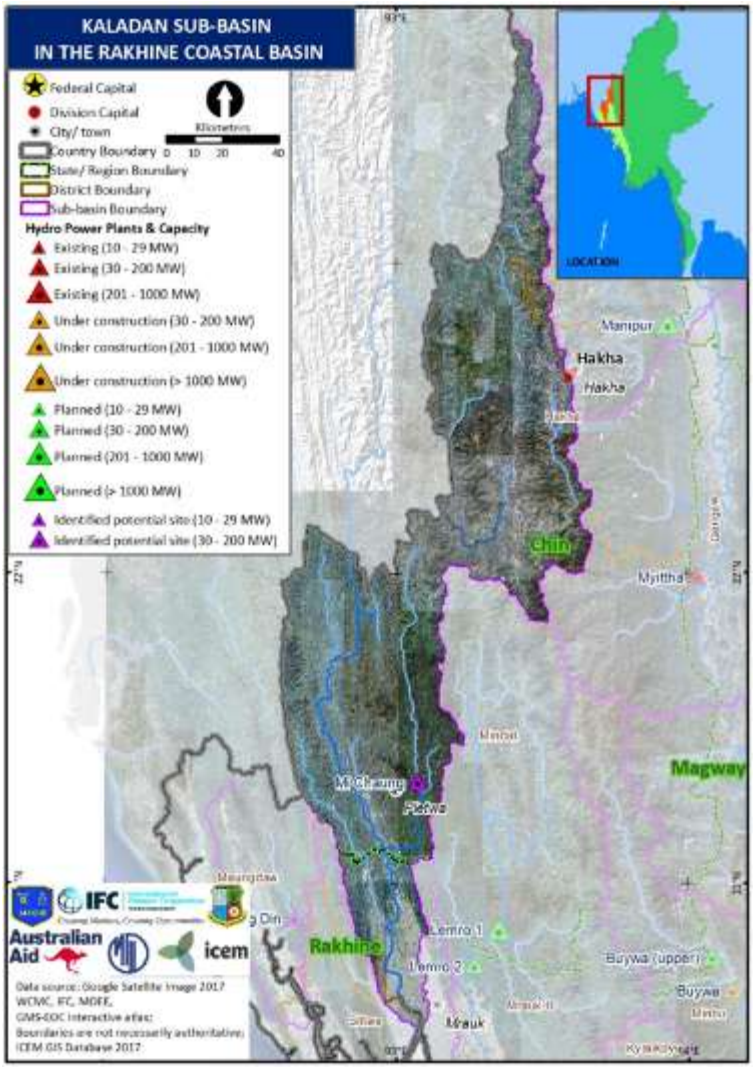
4.9 Rakhine Coastal Basins

4.9.1 Kaladan

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
5	4	2	3	4

Overview



Kaladan is a medium to large-sized sub-basin located in the Chin and Rakhine states in the western part of Myanmar.

Area: 13,618 km^2

Average rainfall: 2,665 mm

Average sub-basin outflow: N/A

Topography:

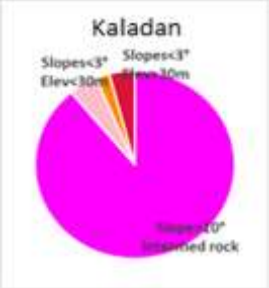
Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	5%
Slopes<3 Elev<30m	4%
Slopes<3 Elev>30m	2%
Slopes>10 hard rock	0%
Slopes>10 intermed rock	89%

Socio-economic	Population: 320,527 Ethnic diversity: Chini, Lushei Economic activities: + Mining area: No + Navigable waterways: 92.5 km + Land use: N/A
Administrative:	States/Regions: Chin, Rakhine Major town/s: Paletwa, Kyauktaw, Rezua, Rihkhawdar, Thantlang

Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 0 Identified potential site: 1 (Mi Chaung – 200 MW)

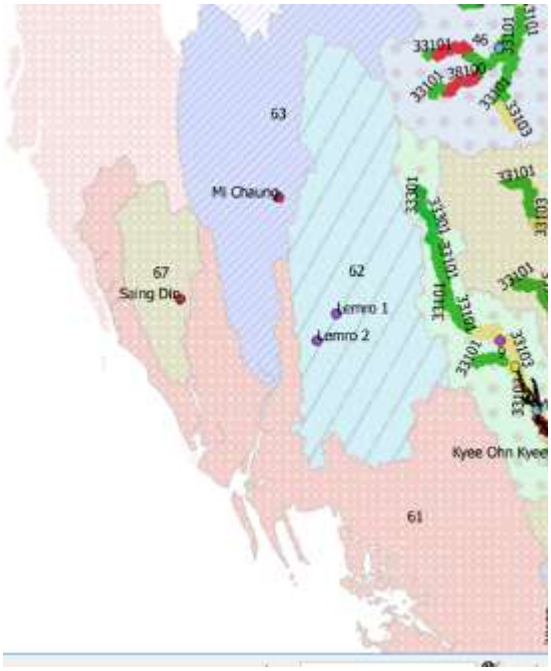
Geomorphology and sediment	Rating	5

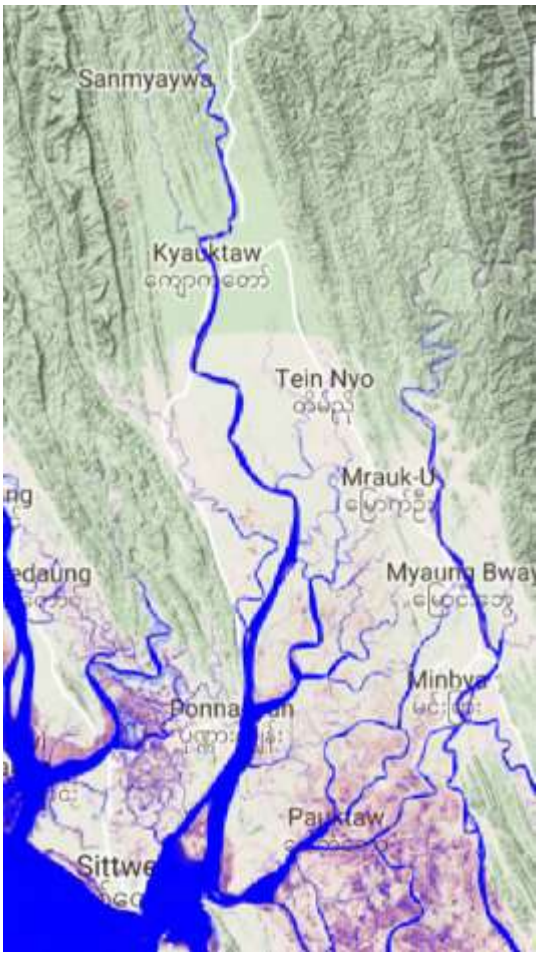
- The Kaladan is a large sub-basin (65th percentile) and the largest individual tributary in the Rakhine "basin", with a Strahler Order 2 mainstem;
- It flows from the steep mountains in the Arakan range delivering sediment to the Rakhine coast;
- It is considered in very good geomorphic condition similar to the other intact sub-basins in this area.



Aquatic ecology and fisheries	Ecological Value rating	4
	Human Pressure rating	3

- The Kaladan river rises in the Chin hills and flows south west and into its delta and estuary at Sitwe. The Chin Hills have a karst limestone area and it is expected that the river reach types in the upper part of the sub-basin will be similar to the Manipur river. In the lower part the Kaladan river will probably consist of large and medium rivers in moist broadleaf forest region at low elevation. When the river reaches the floodplain area it broadens and forms islands and multiple channels.
- The Kaladan river (similar to the Manipur river) is expected to be an area of endemism for fish and other aquatic organisms. There is





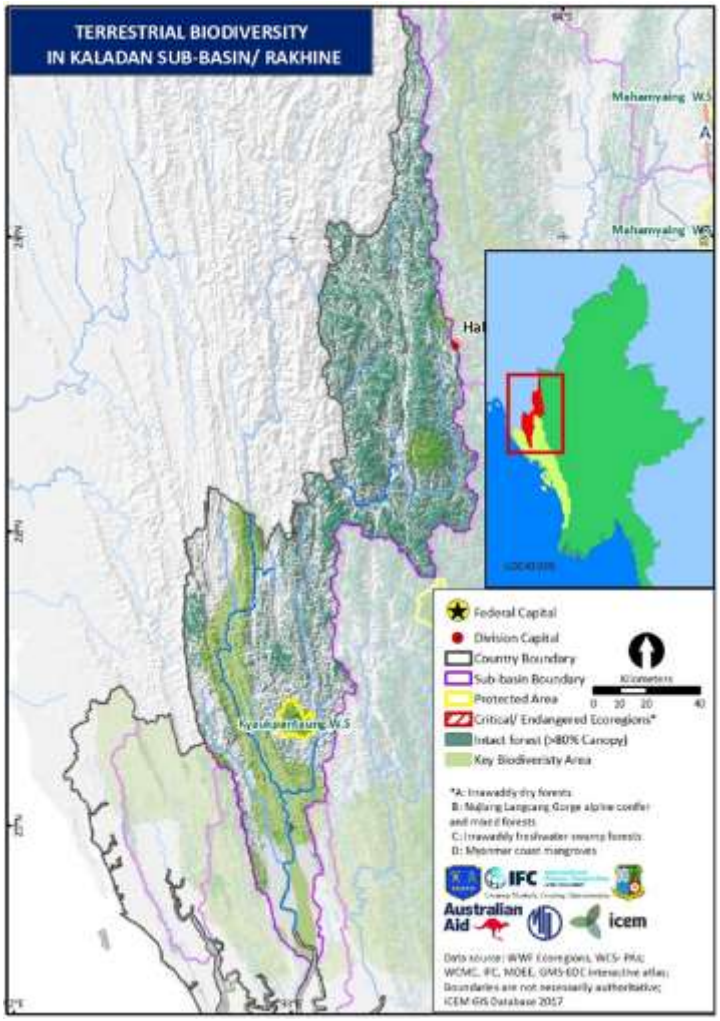
the Mouth of the Kaladan river marine KBA, which is important for water birds, cranes, dolphins and crabs, and the Kaladan river itself has been recognised as a riverine KBA

- Human pressures on the aquatic ecology are focussed on the floodplain area with high

population density and agriculture.

- One hydropower project has been identified – Mi Chaung HPP (200 MW).

Terrestrial Biodiversity	Rating	2



The Kaladan sub-basin is moderately covered with KBA (18%) and intact forest (29%). The KBA is a habitat for elephants and is an important trans-boundary wildlife corridor. Many endemic species of fish reside in this sub-basin as well. Although it only makes up a small portion of the total area (<1%), the Kyaukpantaung Wildlife Sanctuary is in the sub-basin as well.

Social, livelihoods, and significant sites	Rating	3

In the Kaladan sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 22% of the workforce. Female-headed households, which indicate social vulnerability accounts for 21% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 20%. The ethnic minority groups in the sub-basin are Chini and Lushei. On this basis, the sub-basin vulnerability rating is 3.

Conflict	Rating	5

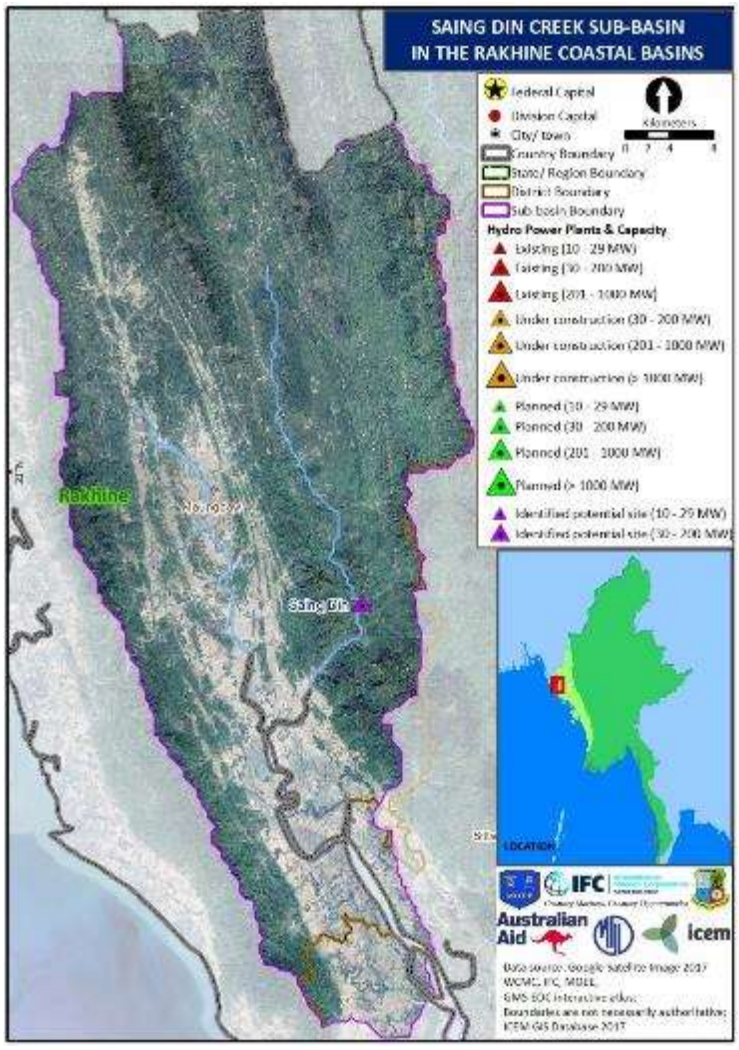
- Multiple armed group influential in less than half of the sub-basin (medium)
- 16 estimated battle deaths 1989-2015 (low)
- 11 2012-2016 media-reported armed conflict incidents (very high)
- 4732 estimated historical conflict-related displaced people (high)
- These ratings were calculated before the intense violence and displacement close to this region in 2017. The vulnerability has been upgraded to 5.

4.9.2 Saing Din Creek

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
1	2	3	2	3

Overview



Saing Din Creek is a small sub-basin located in the Rakhine state in the western region of Myanmar and shares a border with Bangladesh.

Area: 2,331 km^2

Average rainfall: 4,428 mm

Average sub-basin outflow: N/A

Topography:

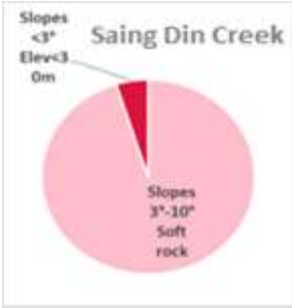
Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	95%
Slopes<3 Elev<30m	5%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	0%
Slopes>10 intermed rock	0%

Socio-economic	Population: 55,545 Ethnic diversity: Mru, Chin (Mro-Khimi), Economic activities: + Mining area: No + Navigable waterways: 74.4 km + Land use: N/A
Administrative:	States/Regions: Chin, Rakhine Major town/s: Buthidaung

Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 0 Identified potential site: 1 (Saing Din – 76.5 MW)

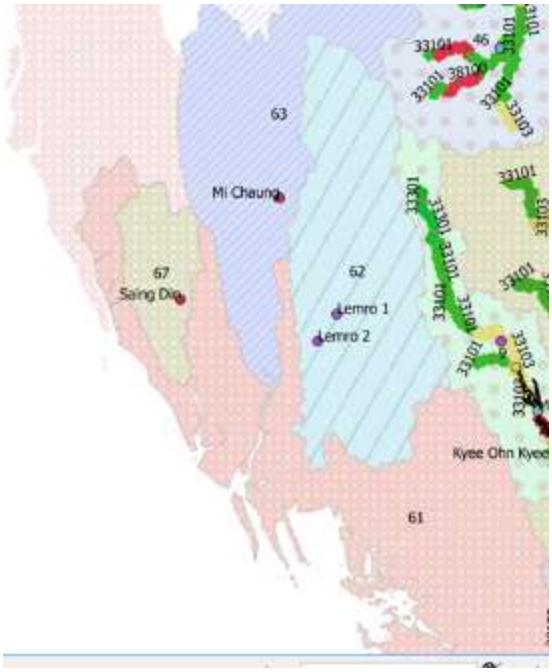
Geomorphology and sediment	Rating	1 (5)

- The Saing Din Creek sub-basin is very small (16th percentile) with a low Strahler Order river;
- The sub-basin includes the undulating hills in the Rakhine Coastal area;
- The small sub-basin has low geomorphology indicators owning to the low flow and sediment potential and low Strahler Order;
- Like the other small Rakhine sub-basins, the low rating is predominantly attributable to the very small size of the sub-basin compared to other sub-basins in the Rakhine and elsewhere.

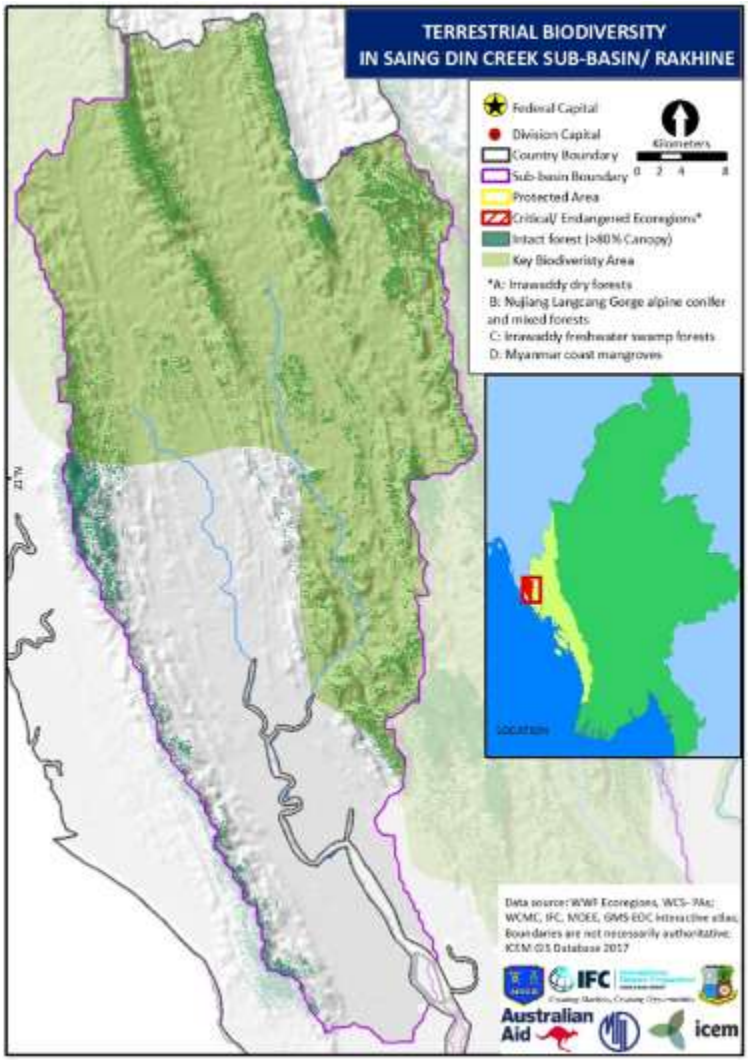


Aquatic ecology and fisheries	Ecological Value rating	2
	Human Pressure rating	3

- The sub-basin where the Saing Din HPP has been identified, is a small sub-basin flowing parallel to the coastline between two low ridges in a wide floodplain some 10 – 15 km wide. The river itself rises in Bangladesh.
- In Myanmar, the river is expected to be a Large river, in moist broadleaf forest region at low elevation, with floodplains.
- Three coastal KBAs are located near the mouth of the river, May Yu, Nantha Island and Oyster Island KBASs
- Human pressures on this sub-basin are moderate with high population density in the flood plain area and agricultural intensity, but little mining activity.
- The Saing Din HPP (75 MW) has been identified on the Saing Din Creek which is a tributary of the main river, rising in the hills to the east of the sub-basin



Terrestrial Biodiversity	Rating	3



The Saing Din Creek sub-basin contains significant regions of KBA (61%), but little intact forest (11%) cover. The KBA in the sub-basin is a habitat for elephants and includes the Northern Yakhine forest complex, an important trans-boundary wildlife corridor.

Social, livelihoods, and significant sites	Rating	2

In the Saing Din Creek sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 19% of the workforce. Female-headed households, which indicate social vulnerability accounts for 22% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 24%. The ethnic minority groups in the sub-basin are Mru and Chin (Mro-Khimi). On this basis, the sub-basin vulnerability rating is 2.

Conflict	Rating	5

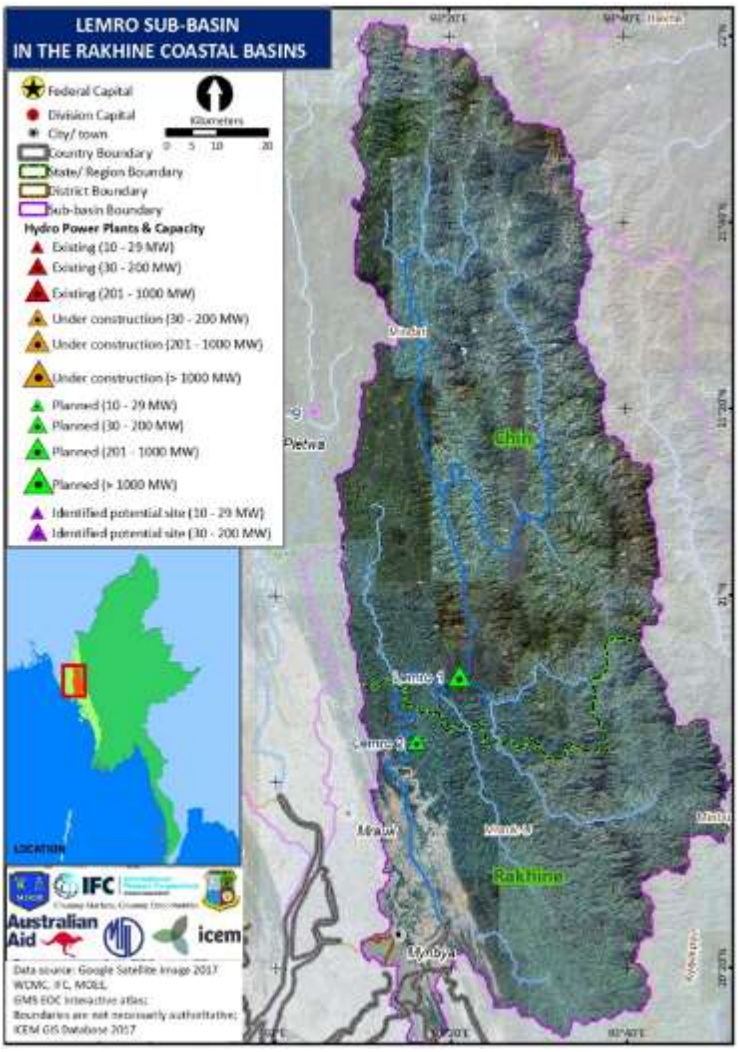
- Armed group influence in some of the sub-basin (medium)
- 29 estimated battle deaths 1989-2015 (medium)
- Two 2012-2016 media-reported armed conflict incidents (low)
- 614 estimated historical conflict-related displaced people (medium)
- These ratings were calculated before violence and displacement in this region in 2017. The vulnerability has been upgraded to 5.

4.9.3 Lemro

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
5	3	3	3	2

Baseline Value Ratings



Lemro is a medium-sized sub-basin located in the Chin and Rakhine states in the western region of Myanmar.

Area: 9,955 km^2

Average rainfall: 2,750 mm

Average sub-basin outflow: N/A

Topography:

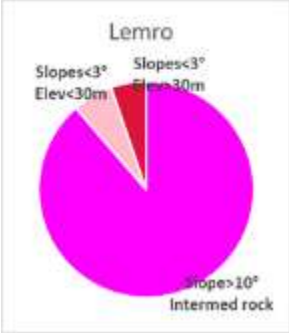
Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	6%
Slopes<3 Elev<30m	5%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	0%
Slopes>10 intermed rock	89%

Socio-economic	Population: 410,189 Ethnic diversity: Chini Economic activities: + Mining area: No + Navigable waterways: None + Land use: N/A
Administrative:	States/Regions: Chin, Magway, Rakhine Major town/s: Mynbya

Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 2 (Lemro 1 – 600 MW, Lemro 2 – 90 MW) Identified potential site: 0

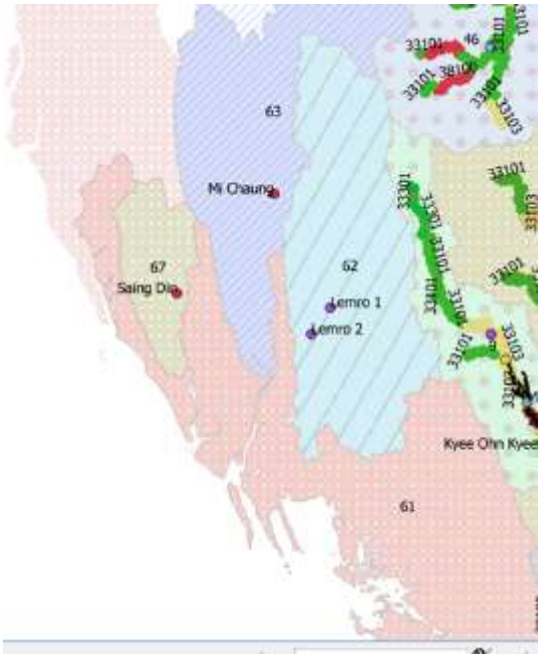
Geomorphology and sediment	Rating	5

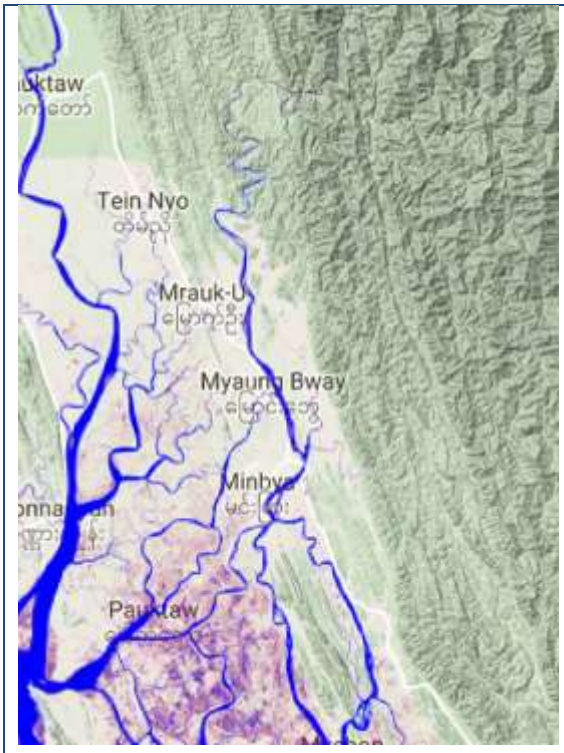
- The Lemro is a medium sized (56th percentile) sub-basin that lies predominantly within the Arakan ranges and discharges to the Rakhine coastal strip;
- The river basin structurally controlled and generally trends in a north south pattern. The large basin is relatively undeveloped, has a Strahler Order of 3, and very high rainfall;
- Like the "other Rakhine" sub-basin these characteristics contribute to a high geomorphology rating of 5.



Aquatic ecology and fisheries	Ecological Value rating	3
	Human Pressure rating	3

- The Lemro river rises in the norther Rakhine Yoma and flows south joining the Kaladan at its estuary at Sitwe. The predominant river reach types are probably large and medium rivers in moist broadleaf forest region at low elevation. In the hills, the river tends to be narrow and fast flowing but when it reaches the coastal plain, it widens within a floodplain with islands and multiple channels.
- The Lemro river is expected to have endemic species of fish, and an assemblage of fish species that are different from the Chindwin tributaries to the east. It has one terrestrial KBA – Min Byar KBA in the centre of the sub-basin.
- The Lemro has moderate human pressures with high rural population in the coastal plain, but lower in the hills, with extensive agriculture in the coastal plain.
- Two hydropower projects are planned Lemro 1 (600 MW) and Lemro 2 (90 MW)





Terrestrial Biodiversity	Rating	3

With over 40% of the Lemro sub-basin composed of KBA and nearly 40% composed of intact forest, it has considerable biodiversity value. The KBA is a habitat for land and marine fauna including bears, leopards, crabs, and more. Natmataung National Park is a protected located in the sub-basin that makes up around 2% of the total area.

Social, livelihoods, and significant sites	Rating	3

In the Lemro sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 14% of the workforce. Female-headed households, which indicate social vulnerability accounts for 24% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 20%. The ethnic minority group in the sub-basin is Chini. On this basis, the sub-basin vulnerability rating is 3.

Conflict	Rating	4

- Some armed group influence in some of the sub-basin (low)
- 9 estimated battle deaths 1989-2015 (very low)
- Zero 2012-2016 media-reported armed conflict incidents (very low)
- 6185 estimated historical conflict-related displaced people (high)
- These ratings were calculated prior to violence and displacement close to this region in 2017. The vulnerability has been upgraded to 4.

4.9.4 Thatay

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
1	4	4	N/A	1

Overview

Thatay is one of the smaller sub-basins and falls within the Bago and Rakhine regions in the western part of Myanmar.

Area: 1,289 km^2

Average rainfall: 2,545 mm

Average sub-basin outflow: N/A

Topography:

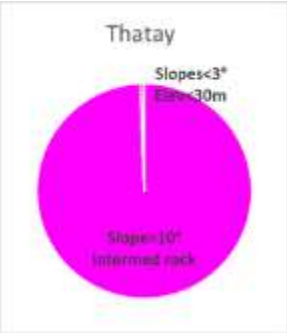
Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	0%
Slopes<3 Elev<30m	1%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	0%
Slopes>10 intermed rock	99%

Socio-economic	Population: 10,943 Ethnic diversity: Chin (Asho) Economic activities: + Mining area: No + Navigable waterways: None + Land use: N/A
Administrative:	States/Regions: Ayeyarwady, Bago, Rakhine Major town/s:

Status of hydropower development	Existing: 0 Under Construction: 1 (Thahtay – 111 MW) Planned: 0 Identified potential site: 0

Geomorphology and sediment	Rating	1

- The Thatay is a very small sub-basin (12th percentile) in the southern Rakhine;
- The river emerges from the steep Arakan mountains and discharges via a very narrow coastal strip;
- The sub-basin receives high rainfall, and has a high sediment input, but a hydropower development near the mouth of the river has regulated has broken the connectivity between the coast and >90% of the catchment area;
- The small size and high degree of regulation contribute to the low geomorphic rating.

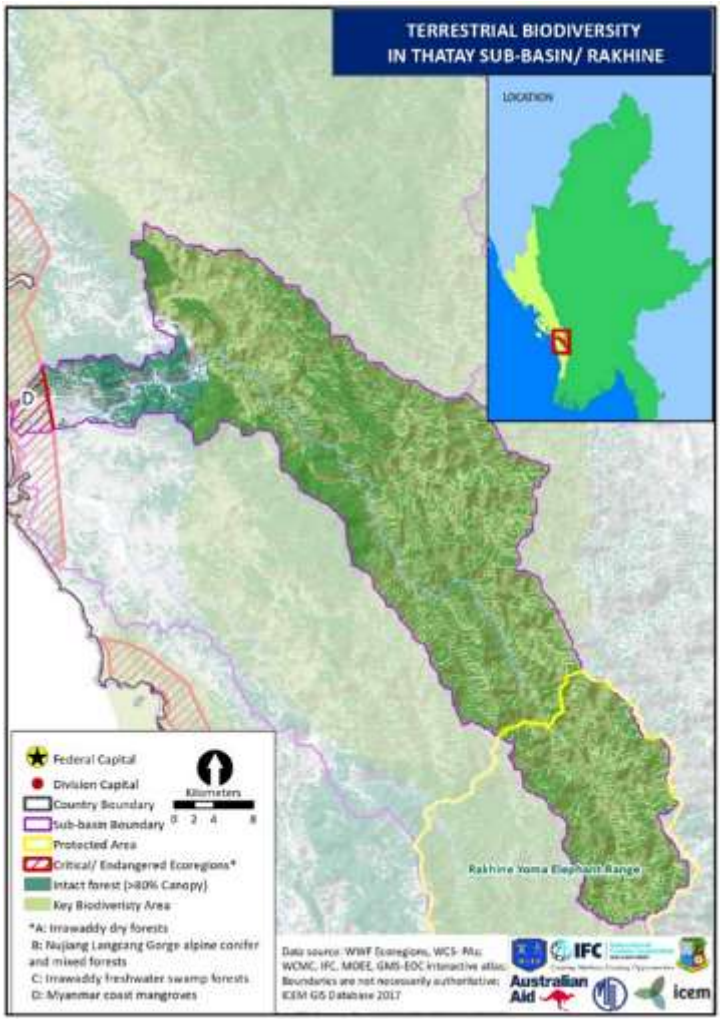


Aquatic ecology and fisheries	Ecological Value rating	4
	Human Pressure rating	3

- The Thatay river is a small river in the southern part of the Rakhine coastal basin, about 20 km north from Thandwe. The river rises in the southern Rakhine Yoma, and it is probable that the upper reaches flow through a karst limestone area, while the lower reaches are likely to be Large river, in moist broadleaf forest region at low elevation, with floodplains. It has a relatively short floodplain before forming a multiple channel estuary with islands near Shwehle.
- Rising in the Eastern Rakhine Yoma KBA and Rakhine Yoma Elephant Range, it is expected to have high aquatic biodiversity, including endemic fish and turtles. It will have a different assemblage of fish species compared to rivers such as the Man Chaung on the other side of the Rakhine Yoma.
- Human pressures are moderate, with relatively high populations density in the lower reaches and agriculture intensity, but low mining activity.

- The Thatay HPP (111 MW) is under construction, though currently stalled. It is located at the point before the river emerges from the hills into the floodplains.

Terrestrial Biodiversity	Rating	4



The Thatay sub-basin is composed mostly of KBA (89%) along with moderate intact forest (37%) cover. The KBA in the region is an important habitat for endemic birds including the spoon-billed sand piper. The Rakhine Yoma Elephant Range is a protected area that encompasses 21% of the sub-basin and in the past another 1% of it contained the critically endangered coastal mangrove ecoregion.

Social, livelihoods, and significant sites	Rating	N/A

The ethnic minority groups in the sub-basin are Chin (Asho)

Conflict	Rating	1

- No or low armed group presence (very low)
- Zero estimated battle deaths 1989-2015 (very low)
- Zero 2012-2016 media-reported armed conflict incidents (very low)
- Zero estimated historical conflict-related displaced people (very low)

4.9.5 Than Dwe

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
1	2	4	1	1

Overview

Than Dwe is one of the smaller sub-basins and falls within the Rakhine state in the western region of Myanmar.

Area: 1,359 km^2

Average rainfall: 3,093 mm

Average sub-basin outflow: N/A

Topography:

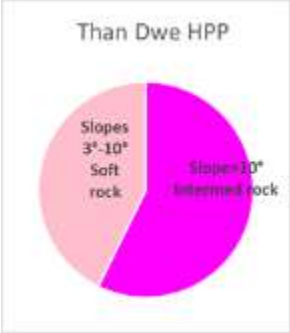
Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	43%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	0%
Slopes>10 intermed rock	57%

Socio-economic	Population: 38,34 Ethnic diversity: Chini Economic activities: + Mining area: No + Navigable waterways: None + Land use: N/A
Administrative:	States/Regions: Ayeyarwady, Rakhine Major town/s: Thandwe

Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 0 Identified potential site: 1 (Than Dwe – 39 MW)

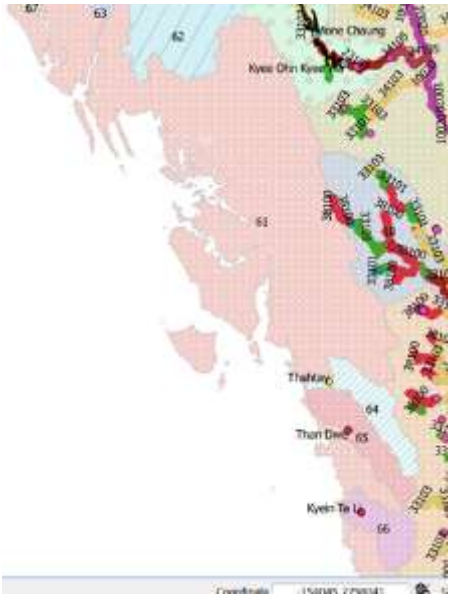
Geomorphology and sediment	Rating	1 (5)

- The Than Dwe sub-basin, targeted for hydropower development, is a very small catchment (14th percentile) with a low order mainstem (Strahler Order -= 1)
- The catchment includes a large area of the gently sloping coastal hills as well as draining the steep Rakhine coastal ranges;
- It receives high rainfall, but due to its very small size and low Order river it has a low geomorphology rating;
- If it was included within the "Other Rakhine" sub-basin it would not alter the "5" score of the other catchment. The low rating indicates it has low geomorphic value on a basin or national scale, largely due to its very small size.



Aquatic ecology and fisheries	Ecological Value rating	2
	Human Pressure rating	2

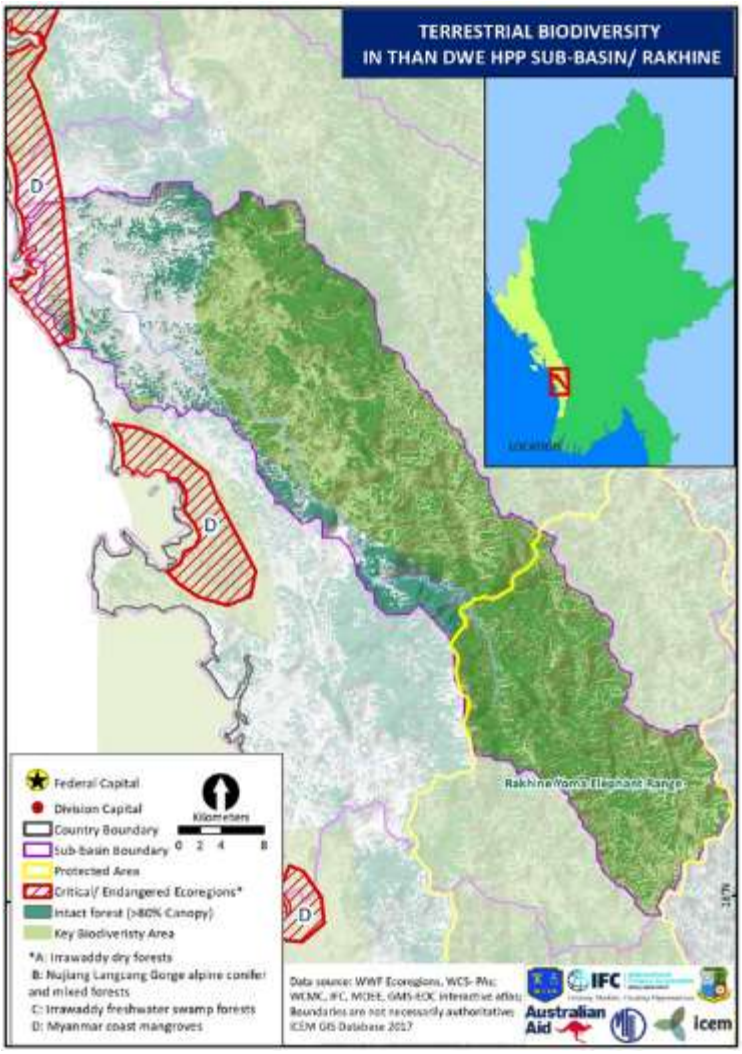
- The sub-basin where the Than Dwe HPP has been identified is a small sub-basin just south of the Thathay river. The river rises in the southern Rakhine Yoma, and it is probable that the upper reaches flow through a karst limestone area, while the lower reaches are likely to be Large river, in moist broadleaf forest region at low elevation, with floodplains and sediment.
- Rising in the Eastern Rakhine Yoma KBA and Rakhine Yoma Elephant Range, it is expected to have high aquatic biodiversity, including endemic fish and turtles. It will have a different assemblage of fish species compared to rivers such as the Man Chaung on the other side of the Rakhine Yoma.
- Human pressures are moderate, with relatively high populations density in the lower reaches and agriculture intensity, but low mining activity. The town of Thandwe



lies on both banks of the river about 18 km from the estuary, and the river valley is well populated and cultivated.

- One hydropower project has been identified for this river basin – Thandwe (39 MW) but the location is not available.

Terrestrial Biodiversity	Rating	4



The Than Dwe sub-basin contains significant KBA (73%) and notable intact forest (44%) cover as well. The KBA in the region is an important habitat for elephants, sun bears, and white handed gibbons. The Rakhine Yoma Elephant Range is a protected area that encompasses 32% of the sub-basin and in the past another 3% of it contained the critically endangered coastal mangrove ecoregion.

Social, livelihoods, and significant sites	Rating	1

In the Than Dwe sub-basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 22% of the workforce. Female-headed households, which indicate social vulnerability accounts for 19% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 38%. The ethnic minority groups in the sub-basin are Chini. On this basis, the sub-basin vulnerability rating is 1

Conflict	Rating	1

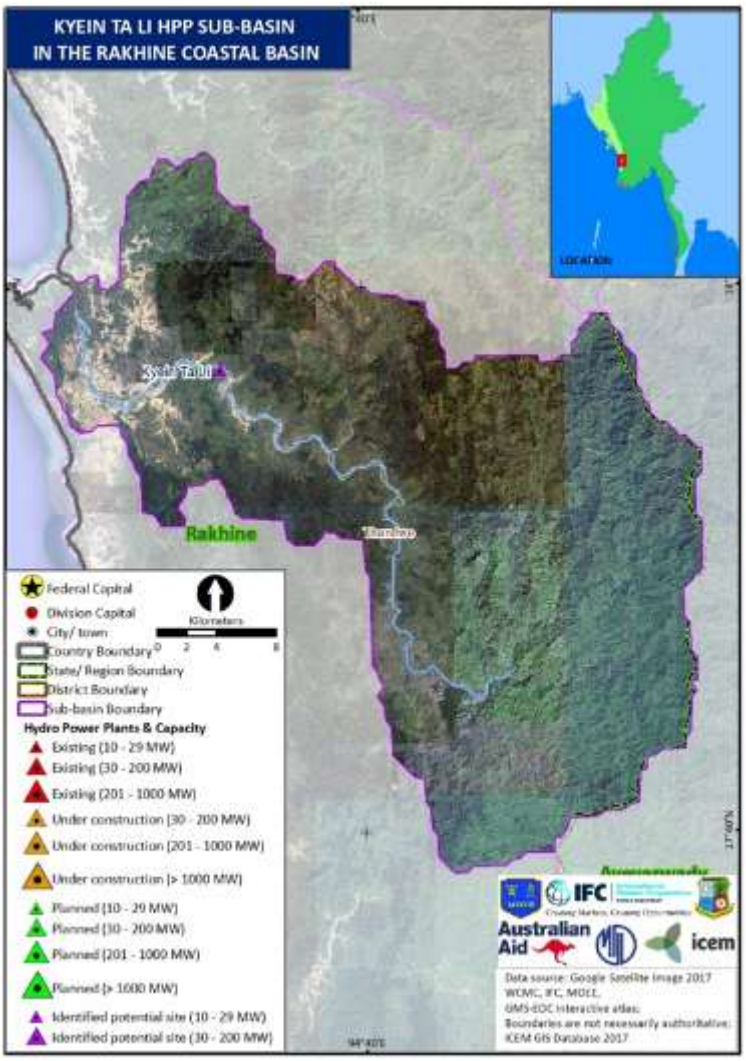
- No or low armed group presence (very low)
- One estimated battle deaths 1989-2015 (very low)
- Zero 2012-2016 media-reported armed conflict incidents (very low)
- Zero estimated historical conflict-related displaced people (very low)

4.9.6 Kyein Ta Li

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
1	2	4	N/A	1

Overview



Kyein Ta Li is the fifth smallest sub-basin and is in the Rakhine state in the southwestern region of Myanmar.

Area: 1,061 km^2

Average rainfall: 3,027 mm

Average sub-basin outflow: N/A

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	32%
Slopes<3 Elev<30m	0%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	0%
Slopes>10 intermed rock	68%

Socio-economic	Population: 9,842 Ethnic diversity: Chin, Asho Economic activities: + Mining area: No + Navigable waterways: None + Land use: N/A
Administrative:	States/Regions: Ayeyarwady, Rakhine Major town/s:

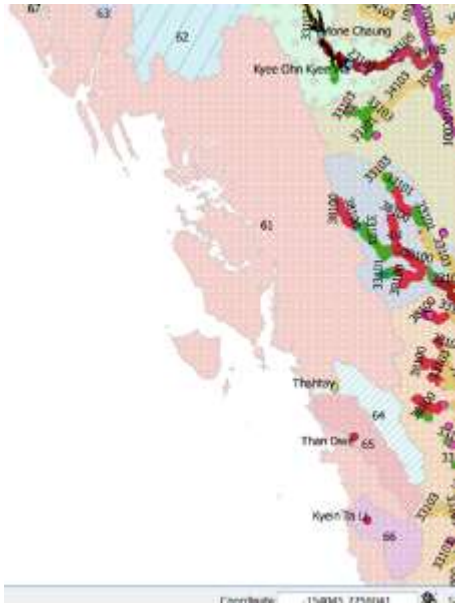
Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 0 Identified potential site: 1 (Kyein Ta Li – 28 MW)

Geomorphology and sediment	Rating	1 (5)

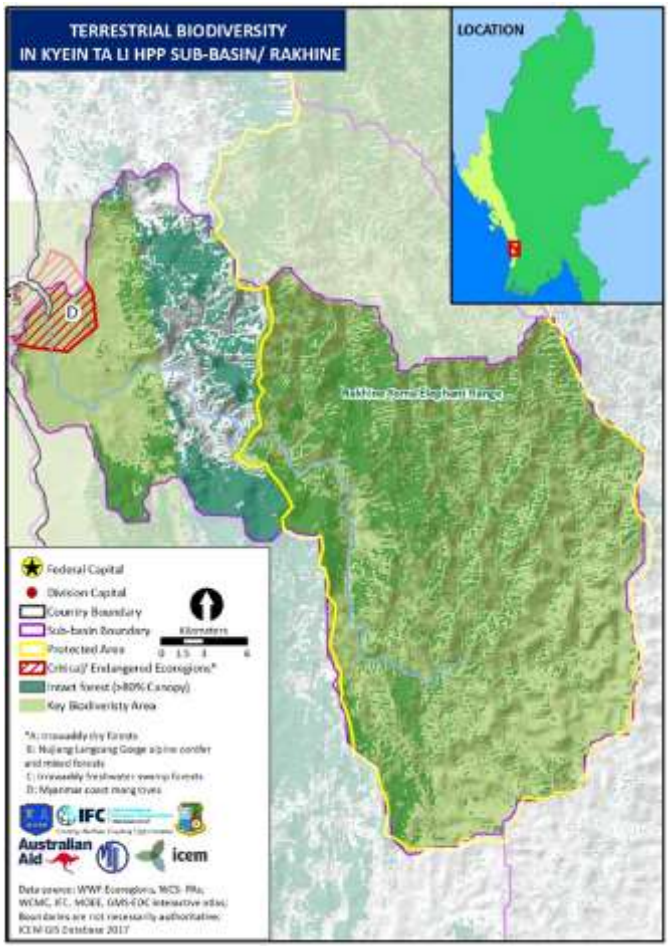
- This very small sub-basin (7th percentile) is very similar to the Than Dwe, in its size and because it is targeted for potential hydropower development;
- Compared to the large sub-basins in the Rakhine and rest of Myanmar, it has low geomorphic significance, due to its small size and low Strahler Order tributary

Aquatic ecology and fisheries	Ecological Value rating	2
	Human Pressure rating	2

- The sub-basin where the Kyein Ta Li HPP has been identified is a small sub-basin just south of the Thandwe river. The river rises in the southern Rakhine Yoma, and it is probable that the upper reaches flow through moist broadleaf region with low and high gradients, while the lower reaches are likely to be Large river, in moist broadleaf forest region at low elevation, with floodplains and sediment. It flows into a very complex delta area with many channels and alluvial deposits, before reaching the sea
- Rising in the Rakhine Yoma Elephant Range, it is expected to have high aquatic biodiversity, including endemic fish and turtles. It will have a different assemblage of fish species compared to rivers such as the Man Chaung on the other side of the Rakhine Yoma.
- Human pressures are moderate, with relatively high populations density in the lower reaches and agriculture intensity, but low mining activity.
- One hydropower project has been identified for this river basin – Kyein Ta Li HPP (28 MW) but the location is not available.



Terrestrial Biodiversity	Rating	4



The Kyein Ta Li sub-basin is small, but still an important area in the context of biodiversity. Over 84% of the sub-basin is composed of KBA that provides a habitat for Dugongs, which is considered a vulnerable species. Intact forest makes up more than 32% of the sub-basin, and over 70% is a protected area known as the Rakhine Yoma Elephant Range. There is also a small presence (1%) of the critically endangered coastal mangrove ecoregion.

Social, livelihoods, and significant sites	Rating	N/A
The ethnic minority groups in the sub-basin are Chin and Asho.		
Conflict	Rating	1

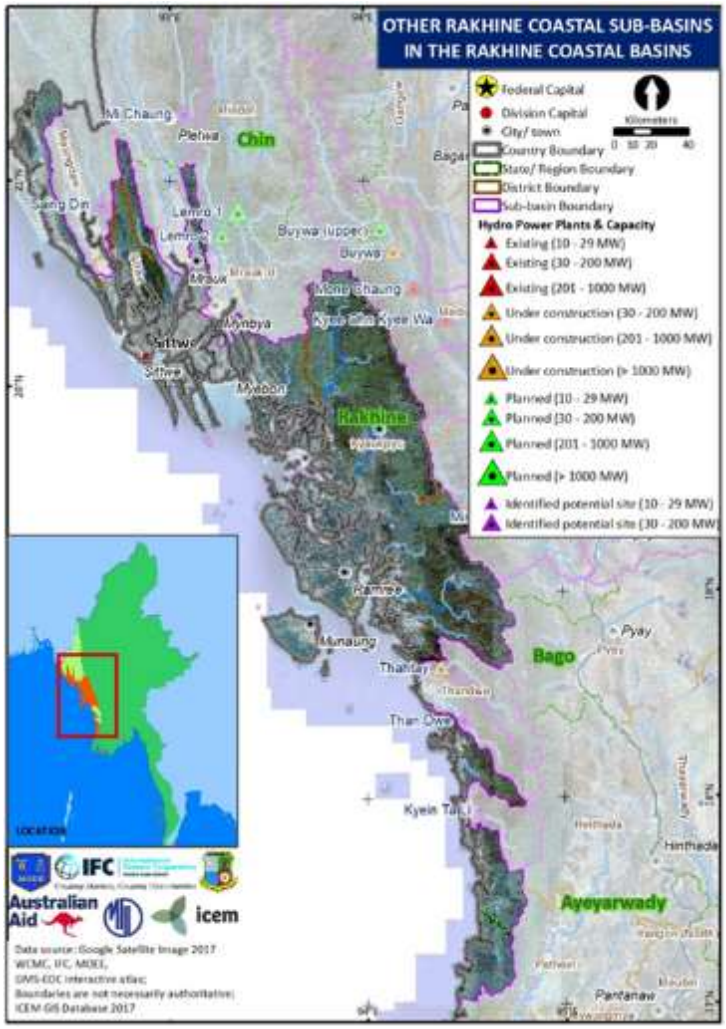
- No or low armed group presence (very low)
- Zero estimated battle deaths 1989-2015 (very low)
- Zero 2012-2016 media-reported armed conflict incidents (very low)
- Zero estimated historical conflict-related displaced people (very low)

4.9.7 Rakhine Coastal Basins Other

Baseline value ratings

Geomorphology and sediment	Aquatic ecology and fisheries	Terrestrial Biodiversity	Social and livelihoods	Conflict
5	2	3	3	4

Overview



Rakhine Other is the 6th largest sub-basin and spans several states in the western-most region of Myanmar. It shares a border with Bangladesh and outlets to the Andaman Sea.

Area: 25,796 km^2

Average rainfall: 3,679 mm

Average sub-basin outflow: N/A

Topography:

Type	% cover of sub-basin
Slopes 3-10 Hard rock	0%
Slopes 3-10 soft rock	47%
Slopes<3 Elev<30m	26%
Slopes<3 Elev>30m	0%
Slopes>10 hard rock	0%
Slopes>10 intermed rock	27%

Socio-economic	Population: 1,377,840 Ethnic diversity: Chini Economic activities: + Mining area: 0.1 km^2 + Navigable waterways: None + Land use: N/A
Administrative:	States/Regions: Ayeyarwady, Bago, Chin, Magway, Rakhine Major town/s: Ann, Mrauk, Munaung, Myebon, Ramree, Sittwe

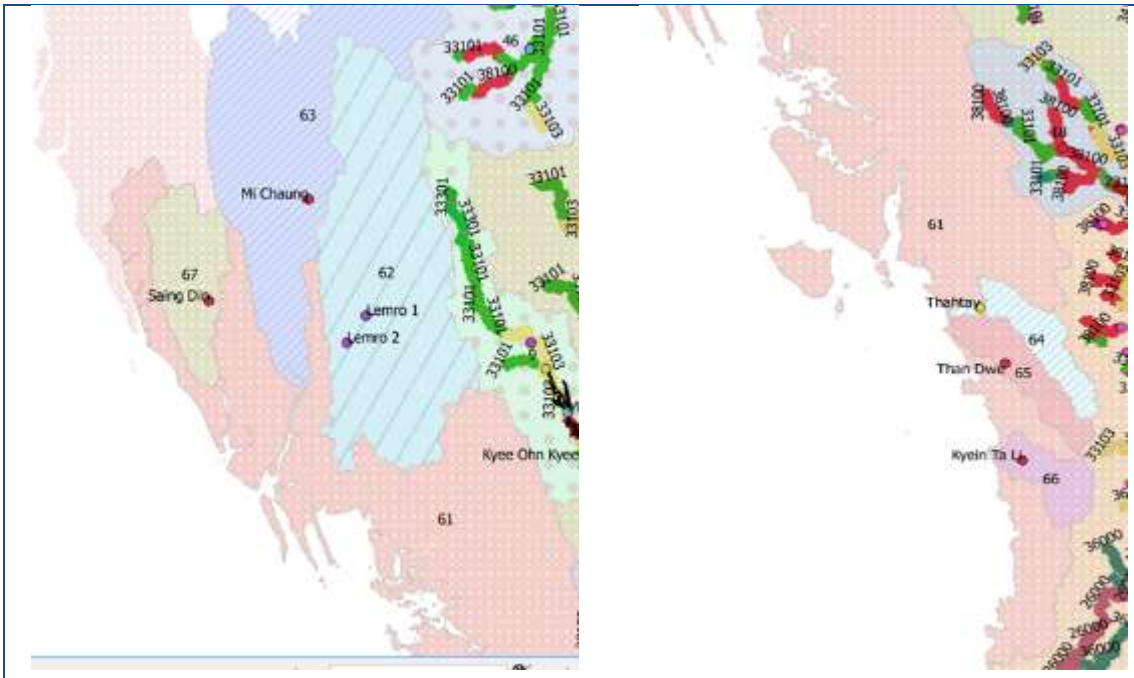
Status of hydropower development	Existing: 0 Under Construction: 0 Planned: 0 Identified potential site: 0

Geomorphology and sediment	Rating	5

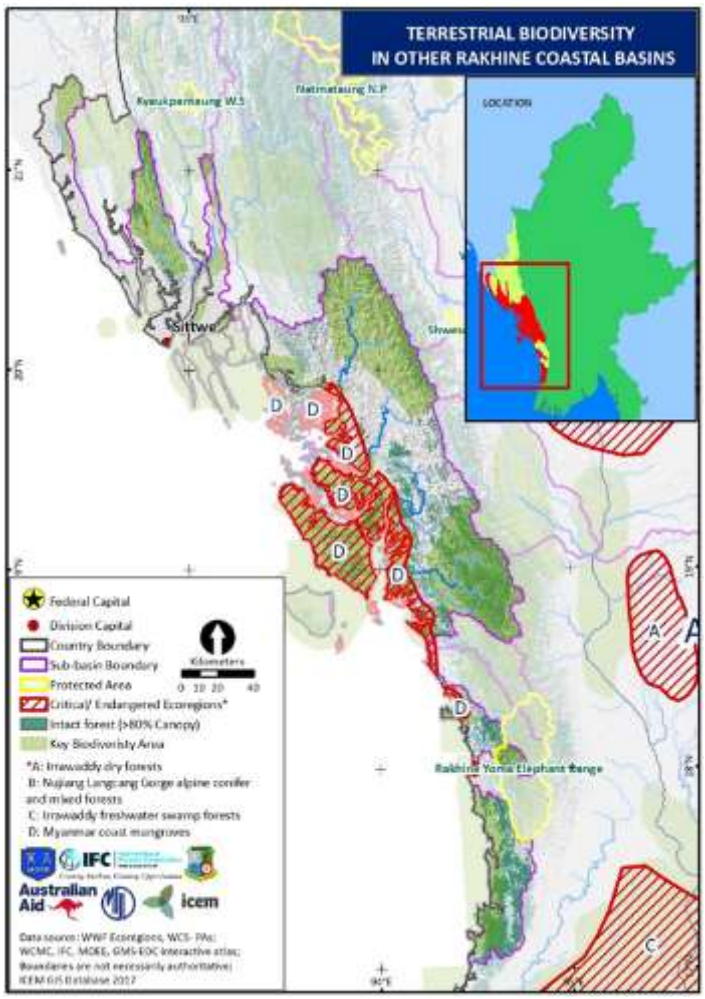
- This sub-basin consists of a group of coastal tributaries that collectively occupy a very large area (91st percentile) and have numerous Strahler Order 3 rivers;
- The catchments drain the steeply sloping "soft" Western Ranges and then spill out onto a low lying coastal complex;
- The coastal areas receive very high rainfall, and all of these factors: size, good connectivity, high sediment and flow input combine for a geomorphology rating of 5.

Aquatic ecology and fisheries	Ecological Value rating	2
	Human Pressure rating	2

- The Rakhine coastal basins are defined by the narrow coastal plain which rises steeply to the east into the Rakhine Yoma, which separates this basin from the Ayeyarwady and Chindwin basins. They fall into the Chin Hills-Arakan Yoma montane forests ecoregion. The area experiences very heavy rainfall during the monsoon because the hills create a rain shadow in the central dry Zone. As a result, the rivers have a more marked difference in flows between wet and dry seasons, with very large flows in wet season and low flows in dry season.
- Apart from the sub-basins described separately, the relatively short rivers all rise in the Arakan
- mountains and flow westwards towards the sea and often create well defined estuaries and small deltas which lead to important island complexes, mangrove areas and sea grass beds.
- The Rakhine Yoma and the rivers flowing from it is a recognised area for endemic fish and other aquatic species. The Chin hills and the lower Rakhine Yoma are also hotspots for endangered and vulnerable fish species, and rare turtle species.
- There are many aquatic KBAs in the area, including the May Yu and Kaladan River estuary in the north, and many of the coastal areas and islands have proposed marine KBAs which are often associated with the estuaries of the rivers.
- Human pressure is largely due to high rural populations and moderately intensive agriculture. Loss of forest cover has occurred in the lower parts of the basin, but the hills have relatively good forest cover.



Terrestrial Biodiversity	Rating	3



The Other Rakhine sub-basin contains 58% KBA and 20% intact forest. The KBA in this sub-basin is a habitat for numerous species, including various birds, mammals, marine fauna, and even marine flora such as coral and sea grass. Nearly 1% of the sub-basin is composed of the Rakhine Yoma Elephant Range. Further, over 15% was made of the critically endangered coast mangrove ecoregion before human development impacted the region.

Social, livelihoods, and significant sites	Rating	3

In the Other Rakhine Coastal Basin's Townships, own account workers indicating livelihood dependence on agriculture and natural resources comprise on average 21% of the workforce. Female-headed households, which indicate social vulnerability accounts for 23% of the households on average. The average percentage of HHs owning a TV, as a proxy for poverty levels, is 22%. The ethnic minority groups in the sub-basin are Chini. On this basis, the sub-basin vulnerability rating is 3.

Conflict	Rating	5

- Low armed group influence in some of the sub-basin (very low)
- 61 estimated battle deaths 1989-2015 (medium)
- 13 2012-2016 media-reported armed conflict incidents (very high)
- 125,081 estimated historical conflict-related displaced people (very high)
- These ratings were calculated before the violence and displacement in this region in 2017. The vulnerability has been upgraded to 5.

4.10 Surma-Meghna Basin

4.10.1 Barak

Baseline value ratings

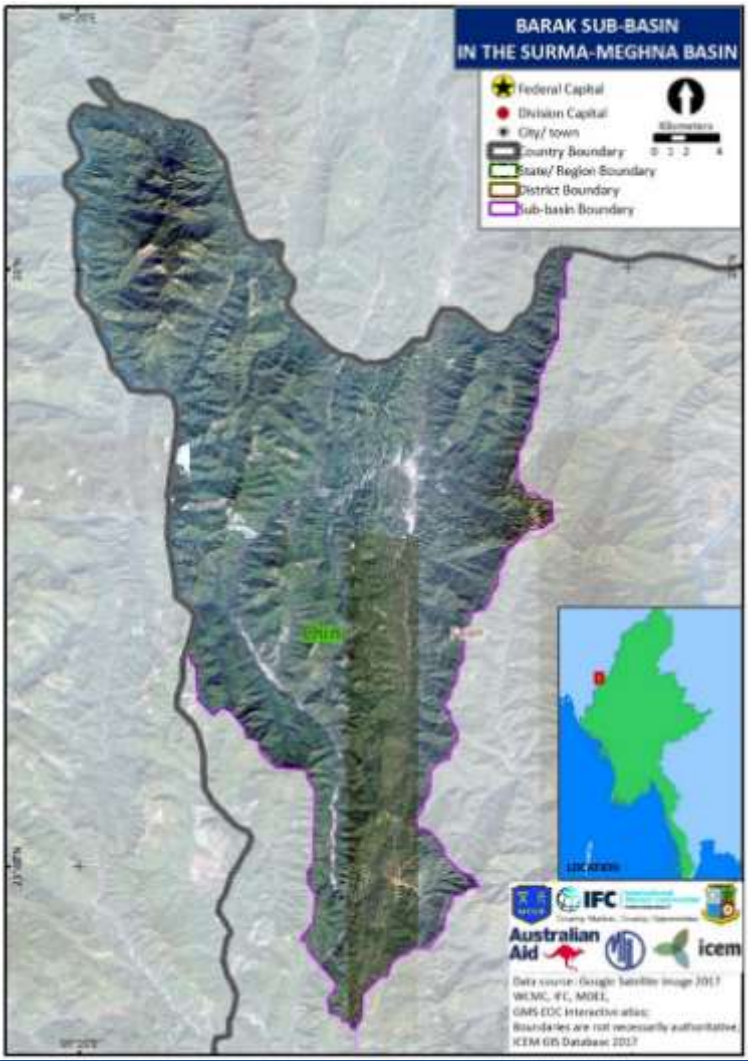
Geomorphology & sediment	Aquatic ecology & fisheries	Terrestrial biodiversity	Social & livelihoods	Conflict
1	3	2	N/A	1

Overview

Sub-basin size = third-smallest in Myanmar
Location = Chin State, western Myanmar, bordering India
Part of the Surma-Meghna basin

Topography:

Type	% cover of sub-basin
Slopes>10 intermed rock	100%



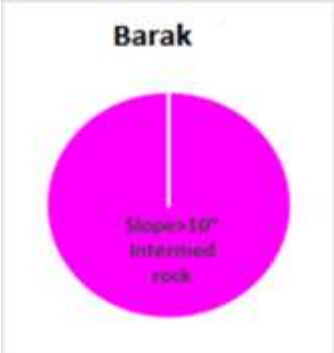
Physical	Area: 792 km^2

	Average rainfall: N/A Average outflow: N/A Minimum outflow: N/A
Socio-economic	Population: N/A Ethnic diversity: Chin (Tedim), Chin (Mizo) Economic activities: + Land use: N/A + Mining area: No + Navigable waterways: None
Administration	States/Regions: Chin Major town/s: Tedim
Hydropower development	Existing: 0 Under Construction: 0 Planned: 0 Identified potential site: 0

Geomorphology and sediment	Rating	1

Sub-basin size: very small (4th percentile; maximum Strahler Order 2)

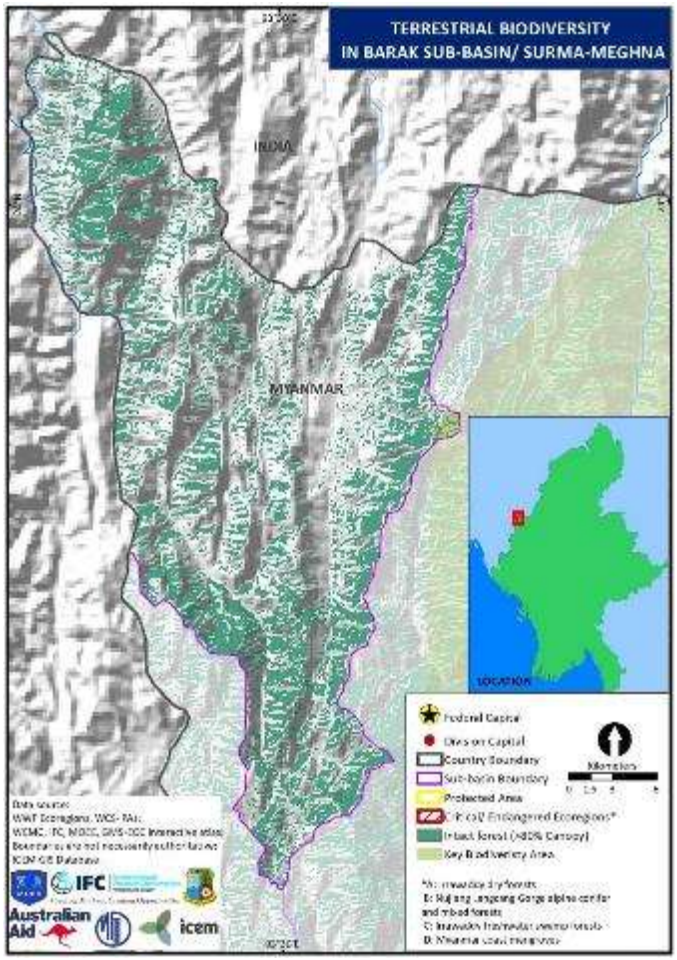
- Located entirely in the Western Ranges and characterized by elevated steep slopes underlain by erodible material and high rainfall.
- Drains north-west out of Myanmar into the Surma river.
- Generally forested but there are denuded areas and evidence of land slips in satellite images.
- The area likely produces a large volume of sediment, which ultimately flows to the Brahmaputra Delta via the Meghna River.



Aquatic ecology and fisheries	Ecological value rating	4
	Human pressure rating	2

- This sub-basin is a small part of the wider Barak catchment, south of the Manipur sub-basin and bordering Myanmar and India.
- The adjoining Manipur river system has a high degree of fish biodiversity; the Barak may have high endemicity with different endemic fish species as it flows into a different river system.
- One of the tributaries of the Surma-Meghna river system; no information is available on the river reach types or flows.
- The Barak rises in the hills, which are generally forested. However, the valleys are populated and intensely cultivated with terraced field systems.

Terrestrial biodiversity	Rating	2



Intact forest cover = 34%
KBA = <1%
Protected area = 0%
Critically endangered ecoregions = 0%

- A large area of intact forest, particularly around the eastern border, which is the primary justification for the biodiversity score.

Social, livelihoods, and significant sites	Rating	N/A
No Census 2014 data were available for the Barak sub-basin.		

Conflict	Rating	1
Armed group presence = none to very low Est. battle deaths (1989-2015) = 0 Media-reported armed conflict incidents (2012-2016) = 0 Historical conflict-related displaced people (est.) = 0		

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