Peat Mapping in Bulungan, North Kalimantan

from Agricultural Development to Conservation Area

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Summary

Indonesia is the world 10th largest greenhouse gas (GHG) emitter, while the country is simultaneously being severely affected by climate change. Extensive deforestation and forest degradation are major contributors to GHG emissions, while peatland destruction is making a significant contribution to deforestation-based carbon emissions and is, therefore, one area in which FORCLIME is active. Bulungan is a district in North Kalimantan province and an area in which FORCLIME is currently working. The district is located along the east coast of Borneo, the world's third-largest island. As peatland destruction represents a substantial source of carbon emissions, FORCLIME decided to support a peat mapping exercise within the province.

In conjunction with the district and provincial government, we selected an area that was in significant need of accurate peat data. The area, which is called the Food Estate, consists of both developed and planned agricultural lands. FORCLIME, in conjunction with its local governmental partners, collected field data within the area. Based on the results of this inventory, it was discovered that the sampled peat in the Food Estate only reached a maximum depth of two meters. This meant that the area did not receive automatic government protection, as the requirements set out under Indonesian regulations stipulate that peat must reach a minimum depth of three meters in order to receive such protection.

Suggestions that the area may be able to receive protection under different legal frameworks were received positively. Moreover, the district government suggested that the overall size of the area should be increased in order to include the surrounding mangrove forest as well. After developing several scientific recommendations and presenting these to the regent, the area was included as a conservation area under the current spatial planning. Some 2,276 hectares of wetlands were thus afforded legal protection from conversion, while the area in question, according to our research, was found to contain up to 11.3 megatons of carbon dioxide equivalent, an amount equal to the annual emissions produced by approximately 2 million cars.

The main factors which have contributed to this success have been: inclusiveness, teamwork, timing and presentation. It is thus recommended that: a) persons working in strategic positions within the government should be included in mapping processes, b) the timing of mapping exercises should be adjusted to that of planning revisions undertaken by the government and c) scientific results should be presented in a manner which can be understood by non-scientists.

Contents

Background Information

Indonesia ranks among the top of the world's biggest greenhouse gas (GHG) emitters, while the country is simultaneously being severely affected by the effects of climate change. Extensive deforestation and forest degradation are major contributors to GHG emissions. Meanwhile, Indonesia's population is increasingly suffering from the consequences of climate change and is becoming ever more aware of the problem and the need for urgent action. Nevertheless, to date, both public and private actors have been unable to make efficient use of existing and emerging international forest conservation and climate protection approaches. This has largely been due to shortcomings in the required political and institutional conditions. In general, capacities relating to planning and the implementation of relevant strategies and methods have been inadequate. FORCLIME's objectives are to improve both the legal and institutional frameworks in areas of forest management, to improve biodiversity conservation and to reduce the GHG emissions produced by the forestry sector.

In order to achieve these objectives, the programme is operating primarily at the level of Forest Management Units (FMUs) and is supporting the following three strategic areas:

1 National and sub-national regulatory frameworks (forest and climate policy).	**2** The establishment of Forest Management Units.	**3** Human Capacity Development (HCD) through training and education centers.

The German TC (Technical Cooperation) contribution involves the provision of national policy advice, strategy development and implementation in the field of forest management and climate protection. The TC is providing advice on:

1 Developing innovative instruments and mechanisms designed to mitigate GHG emissions from forests.	**2** Implementing these in selected FMUs as a best-practice approach.	**3** Feeding the results into the national, regional and international debate on forests and climate protection.

In addition, the TC is providing enhanced basic and further training in forest management through targeted Human Capacity Development activities and supports national and local forestry training centers.

These interventions are being carried out in close coordination with the Financial Cooperation module implemented by the Ministry of Environment and Forestry (MoEF) and funded by the KfW Development Bank. The focus is on areas of forest within FMUs which are exposed to potential and acute risks of degradation or of conversion into other land-use forms. At the same time, there is also the potential to significantly reduce greenhouse gas emissions and to engage in species protection, as well as the protection of water resources within pilot districts located in East Kalimantan, North Kalimantan and West Kalimantan.

Since 2009 the Indonesian-German Forests and Climate Change Programme (FORCLIME) has supported the Indonesian Government and relevant public and private actors in developing and implementing the institutional and regulatory framework, methods and services required for sustainable forest management, natural conservation and a reduction in the greenhouse gas emissions which are produced through deforestation and forest degradation. Key elements of the FORCLIME TC module focus on the development of policies and strategies, as well as on the elements necessary for sub-national implementation through the practical experiences of pilot provinces in Kalimantan. One of the current intervention areas is located in North Kalimantan.

Bulungan

Bulungan is a district in the province of North Kalimantan (Appendix I) and is located along the east coast of Borneo, the third-largest island in the world. The district stretches over 200 km inland and encompasses a wide variety of natural landscapes e.g. karst, mangrove forests, swamps and tropical rainforests. The Kayan river runs through the district from the far west all the way to the east, where it meets the ocean in what is called the Kayan Delta. North of Bulungan the Sembakung river meets the ocean, forming an adjacent delta.

The Kayan Delta is a large system of mangroves, swamps and peat forests which is primarily utilized for aquaculture. In the combined delta (Kayan – Sembakung) approximately 1,500 km^2 of mangrove forest has been converted to aquaculture since the 1980s.

The main town in Bulungan is Tanjung Selor, which is also the capital of the province. The population of the Tanjung Selor subdistrict is approximately 52,000, of which around 30,000 people live in the actual town itself. Both the provincial and district governments are seated in Tanjung Selor.

The Food Estate

In order to increase food self-sufficiency within the province, as well as to support local and transmigrant farmers, the provincial government initiated the Food Estate project back in 2015. The Food Estate covers an area of 41,143 hectares, which was originally mainly covered mangrove and swamp forests. Currently, most of the overall area has already been developed, while only small areas of peat and mangrove forest remain intact. The main commodities produced in the converted areas comprise rice and corn. In addition, many kinds and fruits and vegetables are also grown in the Food Estate. East of the Food Estate, aquaculture is more dominant. The primary aquaculture focus here is shrimp farming, in particular, the Asian tiger shrimp (*Penaeus monodon*). In addition, crab and milkfish (*Chanos chanos*) are cultured in the area's large ponds.

The Kayan Delta Revitalization Programme

As a result of a large reduction in aquaculture productivity in North Kalimantan and a heavily compromised coastal ecosystem, the provincial government decided to initiate the Kayan Delta Revitalization programme. This programme is aiming to restore the balance between economic benefits, environmental services and social welfare. GIZ is supporting this program through the mapping of shrimp-farming communities, the development of silvo-aquaculture through social forestry initiatives and through the mapping of peatlands in a bid to promote informed decision making.

Peatlands

Peatland destruction makes a significant contribution to deforestation-based carbon emissions and is, therefore, one area in which GIZ is active. Peat is a type of soil which comprises accumulated and partially decayed organic material. Under anoxic/anaerobic conditions (when submerged) the complete decay of any organic material becomes almost impossible, allowing it to accumulate and ultimately cause the formation of these unique soils (Andriesse 1988). Areas in which the soil is made of peat are often referred to as peatlands or bogs. Peatbogs have a very specific morphological character. As a result of the absorptive character of peat, inland water levels rise allowing for the accumulation of organic materials at ever-higher levels, which eventually leads to the formation of dome-like shapes (Figure 1).
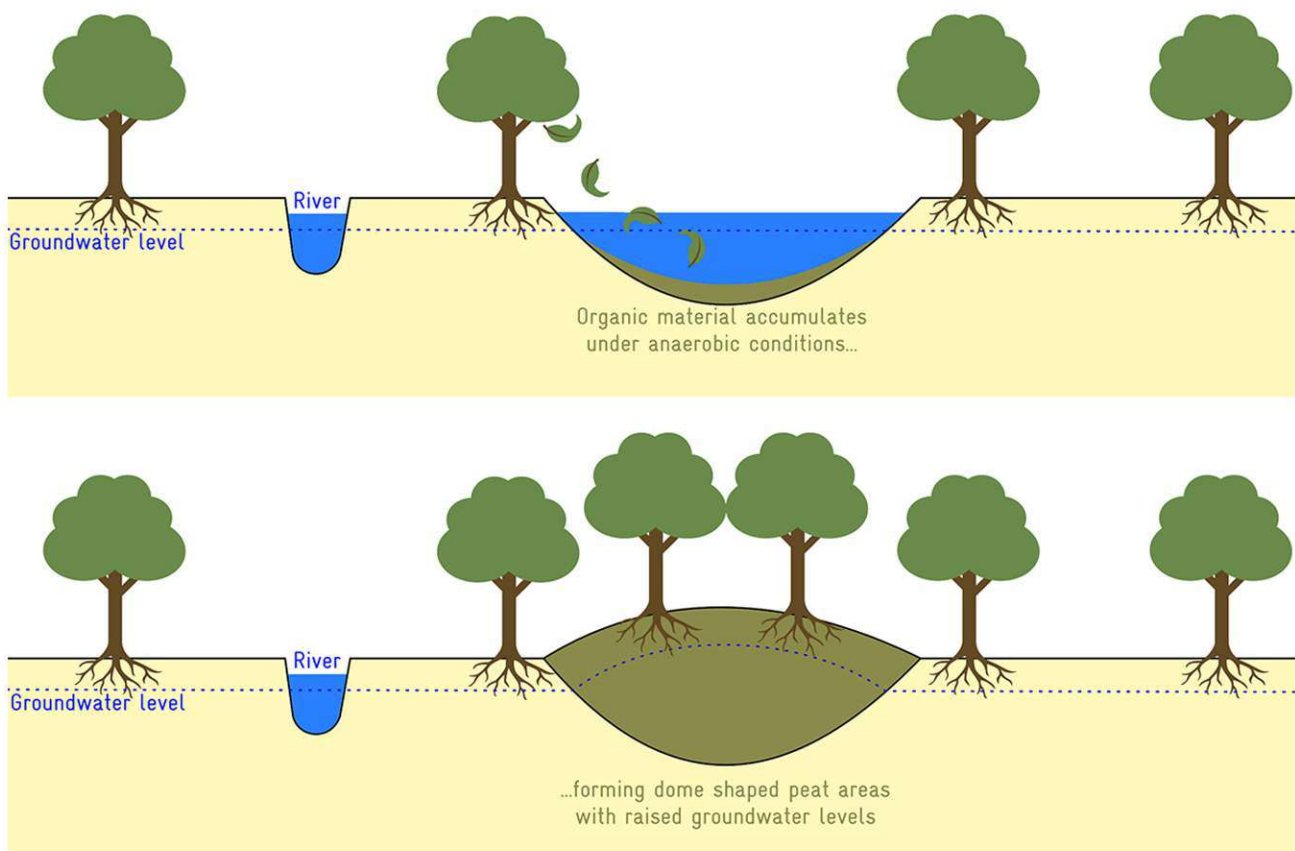
Figure 1. Diagram showing peat formation. (Top) Organic material such as leaves accumulate in stagnant water. As a result of decomposition processes which require oxygen, the water ultimately becomes anoxic (anaerobic). In the absence of oxygen, organic material no longer decomposes and accumulates over time. (Bottom) After thousands of years the accumulated material (peat) starts to form a dome-like shape. This is possible because peat absorbs groundwater like a sponge, which raises groundwater levels and allows for further peat formation.

Peatland formation is an important carbon sink. In tropical peatlands, the annual vertical growth of peat soils can exceed 1 mm per year. In terms of carbon sequestration, this equals a total carbon accumulation that ranges between 40 to 50 grams of carbon per square meter per year (g C m-2 y-1). This equals a total reduction in atmospheric carbon dioxide of between 1.46 and 1.83 tons per hectare per year (Wust et al. 2007). It should be noted that these numbers only correspond to the carbon accumulation of the soil itself and not to the above-ground biomass.

Due to their important role in the global carbon cycle, it is important to conserve these soils, especially within the increasingly important context of global climate change. For example, peatland fires in Malaysia and Indonesia during the el Nino of 1997 and 1998 resulted in 0.81 to 2.57 Gt in carbon emissions. This is the equivalent of 13% to 40% of the annual mean global carbon emissions from fossil fuels (Page et al. 2009). Due to their unfortunate location in mostly coastal lowlands, peatlands are put under a lot of pressure as a result of land-use changes.

Most of the world's tropical peatlands are located in Indonesia and Malaysia. Indonesia has approximately 15 to 20 million hectares of tropical peatlands, of which most are located in Sumatra and Kalimantan (Borneo) (Page et al. 2007). The total area of Indonesian peatlands equals half the size of Germany. The conservation of peatlands within Indonesia can thus make a significant contribution to an overall reduction in global greenhouse gas emissions.

Mangroves

Mangrove forests are unique coastal ecosystems which are usually located in river estuaries. Tidal influences and fluctuating levels of salinity are typical environmental characteristics which allow for the development of mangrove ecosystems. Tidal influences ensure that soils go through a daily cycle during which they are temporarily flooded (Hutchings and Saenger 1987). These tidal influences also result in significant fluctuations in both temperature and salinity (Hoguane et al 1999). As a result of these conditions, tree species have to be very tolerant in order to survive and thus mangrove forests only comprise a handful of tree species (Macnae 1968).

Mangrove forests offer a number of ecosystem services and are important in terms of coastal protection. They also protect coastal communities from the effects of storms and tsunamis. Mangrove forests can also significantly reduce the force of waves (Marois & Mitsch 2015). For example, during the 2004 Indian Ocean earthquake and tsunami, villages in deforested areas were more severely affected than villages which were surrounded by mangrove forests (Kathiresan & Rajendran 2005). Mangrove forests also contribute to soil formation through processes of sedimentation, as well as to soil stabilization. Without mangrove forests, coastal land would ultimately be reclaimed by the ocean, thus endangering coastal settlements (Shete et al 2009).
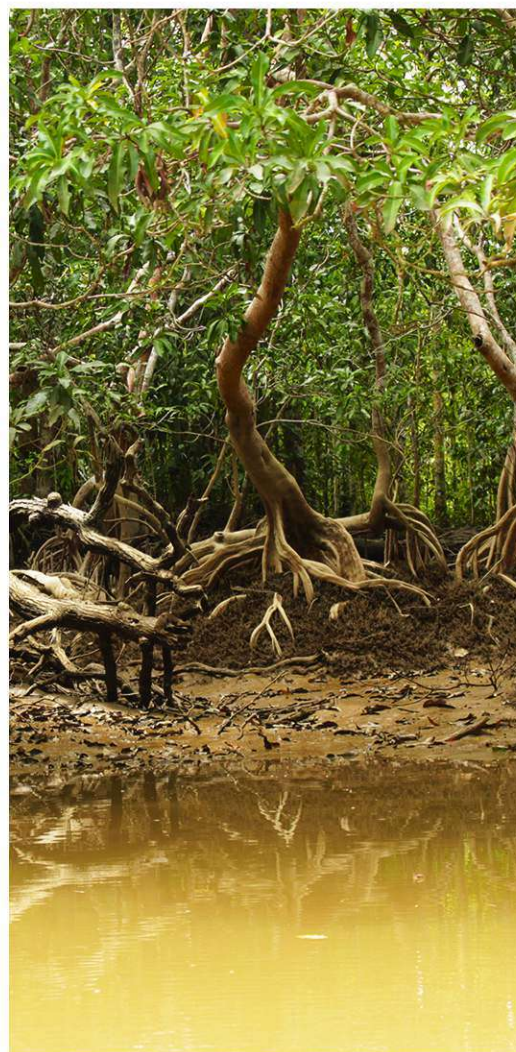
In addition, mangrove forests play an important role in the nutrient cycle, taking up nutrients from the water column and also filtering pollutants from the water (Shete et al 2009, Terada et al 2010). Mangroves can also convert atmospheric carbon into underground biomass (Alongi 2014). In fact, mangrove forests are important carbon sinks that contribute more to carbon storage per hectare than tropical rainforests do (Donato et al 2011).

Finally, mangroves provide timber for fuel, as well as non-timber forest products such as nipah (which can be used to produce sugar), crab and shrimp. Mangrove forests also are important refuges and nurseries for various marine organisms (Primavera 1998). Fisheries are also often highly dependent on mangroves and fish catches are frequently higher near shores that contain mangroves.

All in all, mangroves provide protection to coastal communities, improve water quality, stabilize soils and provide refuge and nurseries for marine organisms.

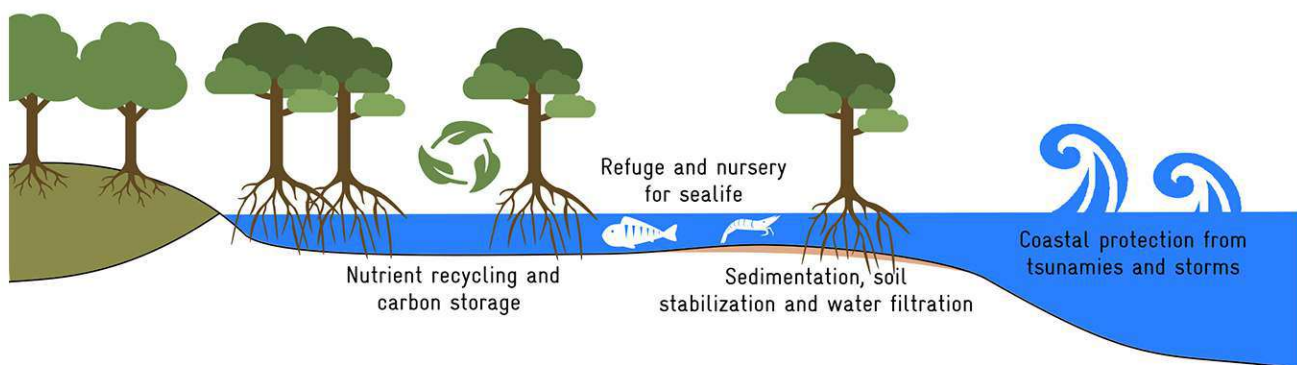**Figure 2.** Mangroves provide many ecosystem services. They protect coastal communities from extreme weather events and tsunamis, they provide refuge and nurseries for the marine life that coastal communities depend for fishing, they help to prevent land from being reclaimed by the ocean through soil stabilization and sedimentation and they also play an important role in carbon storage.

Peat
Mapping
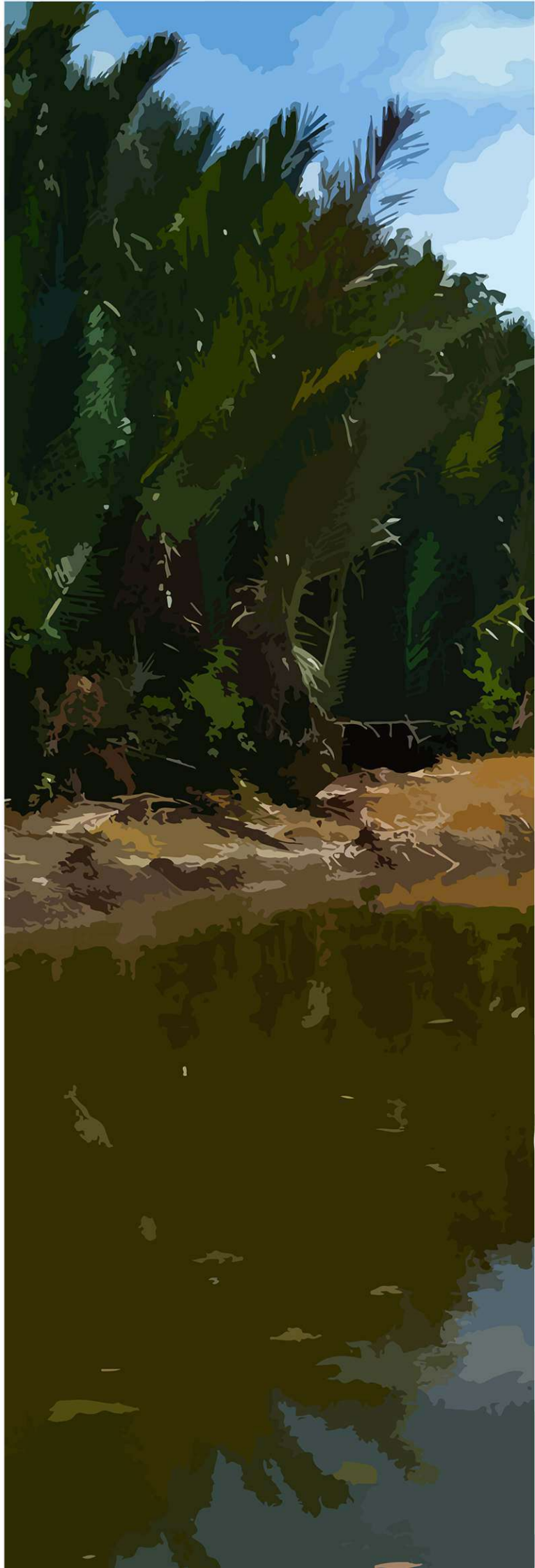
North Kalimantan is Indonesia's newest province and was officially created in 2012 from the province of East Kalimantan of which it was formerly a part. As a result of recent changes to administrative units and government institutions, many new projects and management plans are being developed which focus on the economic, social and environmental well-being of this new province. Essential to the success of such projects is a comprehensive understanding of the available natural resources, ecologically important areas and various other spatial characteristics. As peatland destruction is a significant source of carbon emissions, FORCLIME decided to support a peat **mapping** exercise within the province.

At the time that the peatland mapping process was initiated, no up-to-date data were available. Moreover, the provincial government has also acknowledged that peatland maps are an important element of various projects, which include but which are not limited to:

The revitalization of the Kayan and Sembakung Delta (Provincial Planning and Development Agency).	Spatial planning (Provincial Planning and Development Agency).	Development and planning of the Food Estate and other agricultural projects (Provincial Planning and Development Agency).
Greenhouse gas emissions reduction (Environmental Services).	Conservation of critical ecological systems and species (Environmental Services)	Development of FMU management plans (Forestry Services)
Development of the District Conservation and Management Plan for Peat Ecosystems (PP 71/2014)		

Inclusiveness

From the very beginning, a central element of the peatland mapping project was the involvement of the local government. Peat maps are only useful if they are actually used, and thus our primary aim was to ensure that the peat maps were officially acknowledged so that they could become a part of the area's spatial planning. We therefore invited all of the relevant government stakeholders to a discussion-meeting in order to formulate a peat mapping approach that would be suitable for North Kalimantan. Officials from the Forestry Services, the Environmental Services and the Planning and Development Agency were all present during these initial discussions.

Due to the enormous effort required in terms of field sampling, we agreed to start things off at a pilot location where we would map the extent of the local peat, as well as the peat depth. For all other areas in North Kalimantan, only the extent of the local peat would be mapped. Indicative maps of peatlands showed that there are several large peatlands in the northern districts (Nunukan and Tana Tidung) and some small plots in the southern district of Bulungan. However, the Planning and Development Agency noted that a much greater amount of peat, than was indicated on the indicative maps, could be found in the so-called Food Estate. It was suggested that the Food Estate peat may run to depths of up to three meters. The peat in this area was not part of one of the nationally established hydrological peat units (KHG), nevertheless, all of the stakeholders agreed that this area, which was subject to heavy land-use changes, should be prioritized. We subsequently decided that the peat sampling would be conducted by a team containing staff drawn from all of the involved government agencies. Through this combined team, we were aiming to strengthen involvement and to hopefully ensure the proper integration of the maps produced into the relevant spatial planning.

Training of GIS Staff

During the six months prior to the start of the peat mapping exercise, we trained a group of staff members drawn from the relevant government agencies in the use of geographic information systems. This training was undertaken within the context of a different project. These staff followed an intensive (small groups of four to five participants) four-week training course. After completion, the government employees were able to create maps, create and edit data, undertake basic spatial analysis and use GPS devices in order to collect data and create maps.

The field teams which were to undertake the peat sampling comprised these trained personnel. This ensured that the teams had a proper background in mapping and in the use of GPS. In addition, students from the local university (Universitas Kaltara) were also included in the teams. Universitas Kaltara is a small regional university and has a faculty of agriculture, as well as a director who is heavily involved in conservation. Adding these students to the team allowed the university to develop its knowledge base of peat mapping, knowledge which might subsequently be used in the development of new university curricula.

Peat Mapping

During the course of 2017/2018, the Indonesian Government and the Agency for Geospatial Information (BIG) in particular, working in conjunction with the David and Lucile Packard Foundation, organized a contest aimed at the development of a more cost-effective peat mapping methodology. The contestants who were able to develop the most accurate and cost-effective method stood to win USD 1 million. In the end, the winning method was the brainchild of a German consulting firm (Remote Sensing Solutions GmbH). We decided to implement the new method in order to test it, although it had not yet been designated as an official government standard. The method in question is based on the assumption that a linear relationship exists between peat depth and elevation in dome-shaped peat bogs. The first step involves defining the extent of the peat in a given area, which is completed through the use of digital elevation models (ASTER Global Digital Elevation Map) and historical optical satellite data. Based on the estimated peat extent, transects are then designed for the relevant peat depth measurements. Using this modelling approach, only a relatively small number of measurements are required, making the whole process a cost-effective one. These measurements are then used to model the peat depth based on a high-resolution digital terrain model (Airbus WorldDEM).

During the period September to November 2017, samples were collected along several transects within the Food Estate. These field samples revealed that most of the Food Estate contained mineral soils which were characterized by only very local peat. However, in the north of the study area, peat of up to a depth of 1.65 meters was detected. When modelling the data, though, a clear relationship between peat depth and elevation proved elusive. This meant that in this specific area, peat did not correspond to the typical dome shape. This, in turn, meant that a greater number of samples would be needed in order to undertake an accurate interpolation. Students from Universitas Kaltara collected these additional samples and we were finally able to draw up maps outlining peat depth in the Food Estate (Appendix II) and the extent of the peat coverage across the entire province (Appendix III).

Implementation
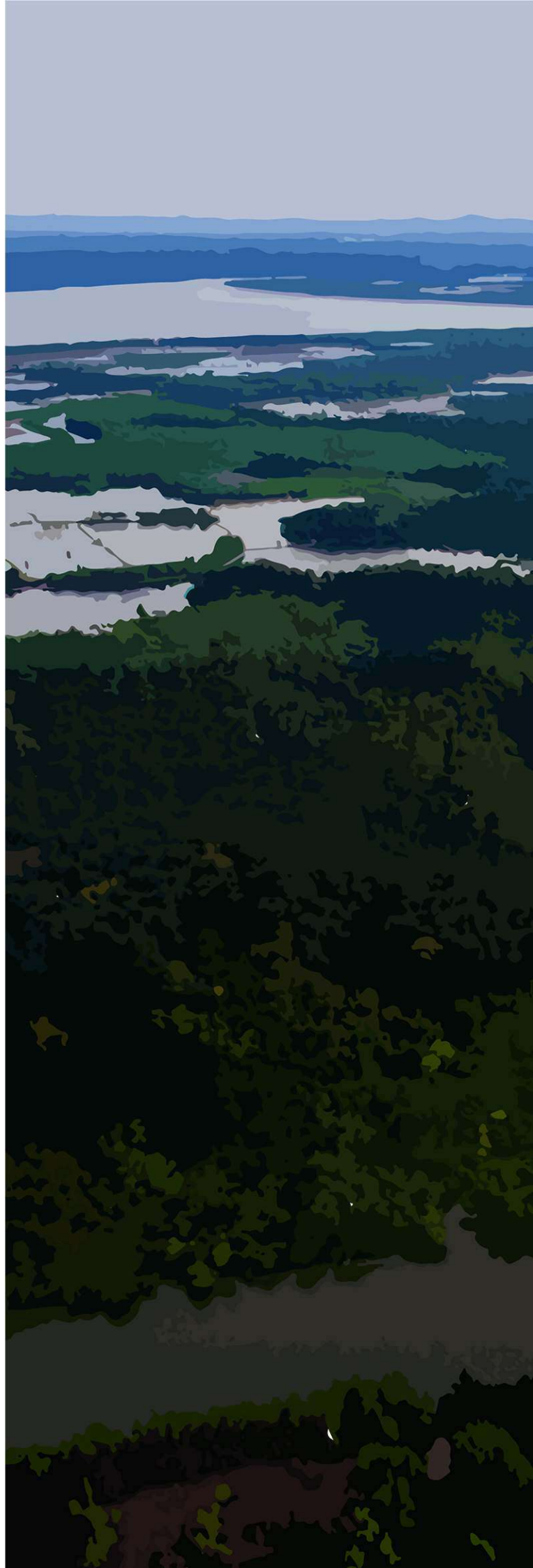
Photographed by:
Dhanny Paratama Putra
National Geographic Indonesia

Legal Framework

In Indonesia, peat which stretches to depths of more than three meters enjoys automatic protection under the law (PP No57 Tahun 2016). This means that the government stopped issuing permits for concessions in these areas after this law came into effect. In addition, existing permits are no longer being extended if they cover areas of deep peat. Established companies are also obliged to avoid earthworks or other modifications which could ultimately alter the soil. The main issue, of course, is that without detailed peat depth maps, such laws cannot be enforced.

The maximum peat depth in the area in which we conducted the peat mapping exercise was found to be 2 meters. This means that the government is not obligated to protect the peat in this area, based on the depth criteria. However, if a district and/or provincial government demonstrate a willingness to conserve such areas, then other options are available. One such legal framework which can be invoked is that of the Essential Ecosystem Area (EEA) (PP No28 Tahun 2011). The EEA is a conservation framework that allows for the conservation of areas which are characterized by high conservation values and which fall outside areas of state forest (kawasan hutan). Such areas, for example, may boast unusually high levels of biodiversity, may have importance from social/cultural perspectives or may provide important ecosystem services to the community.

In order to have a given peat area protected under this specific law, there are two steps which have to be adhered to:

1 First, it has to be clear to the district government why the area has been deemed 'essential'. Particularly in light of the fact that the area in question had previously been designated as part of a prestige project, specifically, the Food Estate.

2 Subsequently, the area had to be included as an EEA in the relevant spatial planning, which had to be agreed upon by the regent/mayor.

Spatial Planning

In 2018, the Planning and Development Agency of the District of Bulungan initiated the revision of their spatial planning. Spatial planning forms the legal basis for all land development and is revised once every five years. From the beginning, FORCLIME was involved with the revisions. However, in order to develop and revise spatial planning, a thorough understanding of GIS is required. During early 2017, we trained two staff members from this specific office, as well as the sub-unit responsible. The resulting personnel was now in charge of revising the spatial planning. These same persons were also part of the peat-mapping field teams. This allowed for the easy integration of peat data into the spatial planning revision process.

During early discussions held with the spatial planning unit, it was proposed that the peat area should be included within the spatial planning as an EEA. The spatial planning unit then suggested increasing the size of the proposed area. In the south of the area sat a number of small plots which had been classified as peatland by the national government (although, in fact, they didn't actually contain any peat). Based on these maps the Planning and Development Agency decided to incorporate a large area of mangrove forest into the EEA as well. The final proposed area covered some 1,050 hectares of primary peat forest, as well as some 1,226 hectares of the mangrove forest surrounding the core peat forest.

The spatial planning unit then asked FORCLIME to draw up a scientific report outlining the size of the area, the extent of the peat present and all of the benefits that would be provided by the area once it was granted official protection (Figure 3). This report was then presented to the head of the District Planning and Development Agency, who responded positively to the idea, thus leading to the inclusion of the proposed area under the draft spatial planning revision.

Audience

In order to encourage the regent/mayor to agree to the proposed conservation area, the Planning and Development Agency organized an audience with him. During this meeting, FORCLIME presented the idea with support from Provincial Forestry Services, District Environmental Services and Universitas Kaltara. During the audience, it was agreed that FORCLIME should draw up both a short scientific report and an MoU in order to support the proposal. In addition, FORCLIME agreed to support the district government through the development of management plans and funding applications which addressed the area in question in relation to its proposed conservation status.

During the following month, a scientific report was compiled and a delegation from the German Embassy, GIZ Headquarters and the program director met with the regent in order to hand over the relevant documents. After the delegation's visit, the regent officially agreed to designate the area as a conservation area and it was subsequently included as an EEA within the final version of the revised spatial planning.

The Food Estate
Why conservation of a small part is 'essential'?

CO_2

Carbon Storage

Reduction of carbon emission from deforestation is equal to the annual emission from 2.000.000 cars.

National policy stipulates that each district should develop a green house gas reduction action plan, to which peat conservation can contribute.

Green Washing

By including a small conservation area within the Food Estate, the project becomes more carbon friendly.

This may help for example to certify products as eco-friendly and so increase the market price.

ECO PREMIUM QUALITY

Peat forest

Mangrove forest

7% area of the food estate can help …

… to reduce 72% of its carbon emission from deforestation.

Seed Dispersal

Due to its unique location the mangroves in this area can provide seeds through natural dispersal to the surrounding fishpond that have to covert their practices to a more natural system (silvofishery) in order to get legal permits. All fishponds located in state forests have to convert to this system.

Seeds can disperse to 21.480 ha fishponds located downstream of the conservation area and within state forests, supporting over 1.187 families.

Research and Education

The area can function as study and research site for the local university. This will allow them to develop excellence in this topic and draw project money from national and international partners focusing on the large peat area in the north of the province.
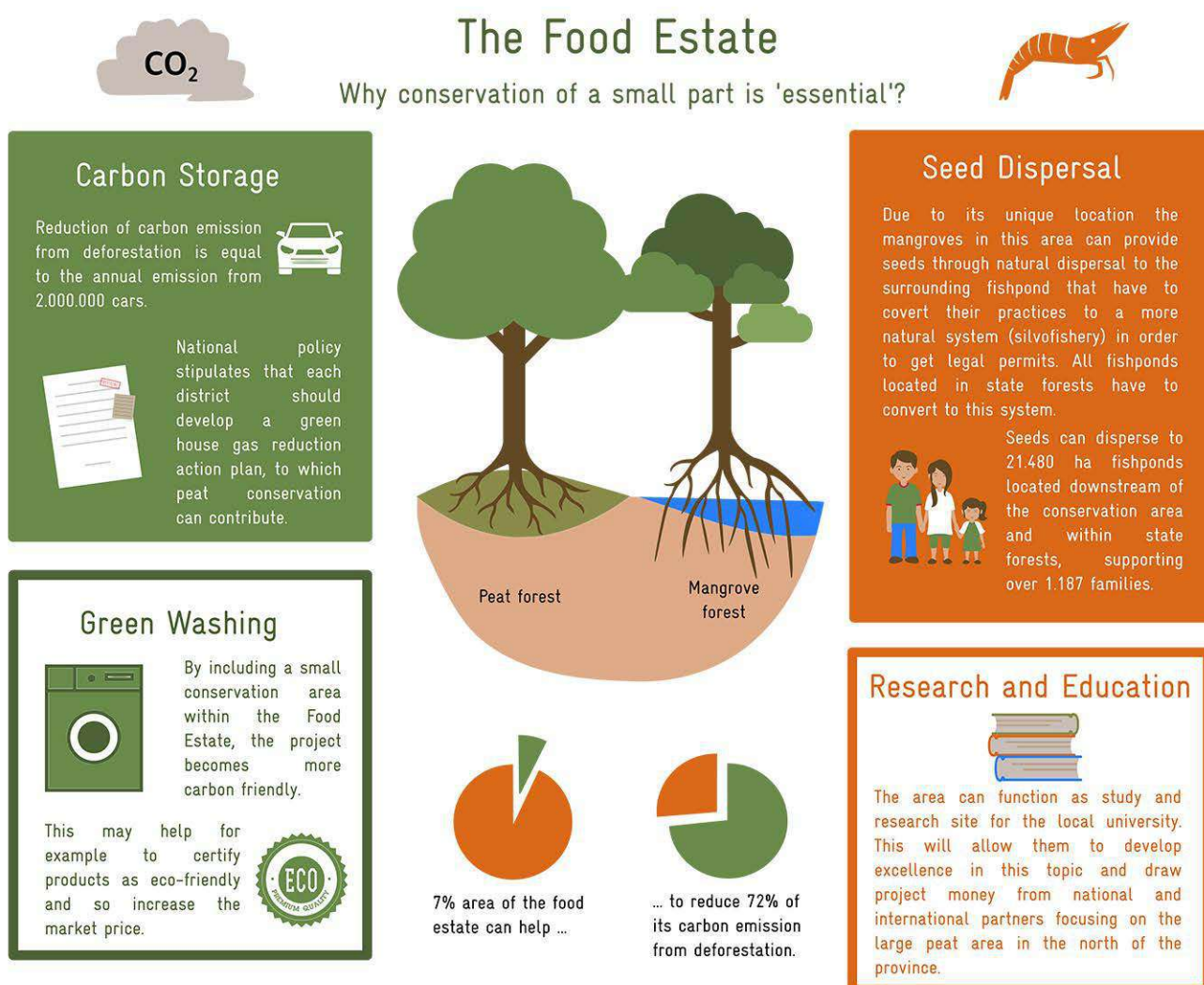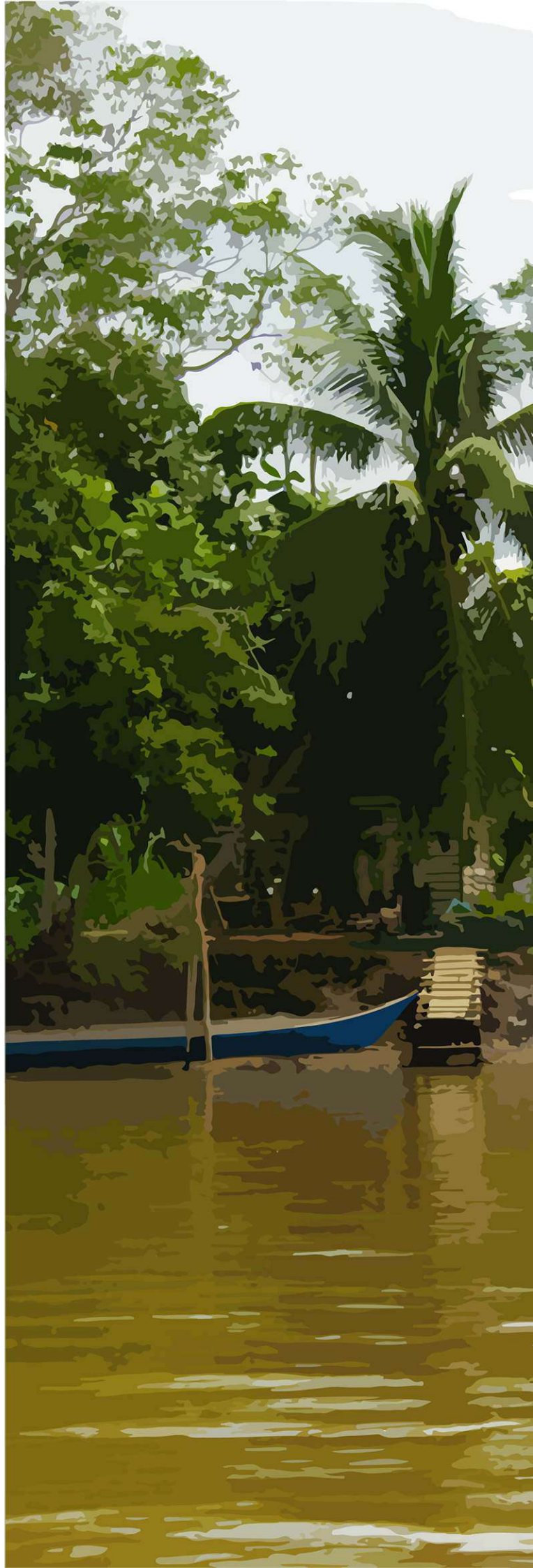
Figure 3. Infographic showing the benefits of conserving the proposed peat and mangrove area.

Recommendations

Several key factors have led to the positive impact created by this peat mapping exercise:

1 Teamwork

From the very beginning of the project, all of the relevant government bodies were included and jointly decided on the relevant areas of focus. The actual mapping exercise was subsequently carried out in conjunction with the various government agencies concerned. This approach gave these agencies a sense of ownership over the data and thus the responsibility to use the data in a sensible way. In particular, the inclusion of the two persons in charge of the spatial planning revisions ultimately had a highly positive effect on the project (and even led to the incorporation of an even larger area than originally designated). In addition, the help that was provided by the local university added extra weight to the push to conserve this important area.

Recommendation:

In terms of future mapping exercises it will be important to include persons within the mapping process who are in strategic positions within the government. In particular, employees in charge of spatial planning can be of great benefit in terms of any mapping project. Including government employees within sampling teams is likely to have a positive effect on the further inclusion and use of such data by the relevant government bodies.

2 Timing

Spatial planning is only revised on a five-yearly basis. In our case, the mapping process was thankfully finalized around the same time as these spatial planning revisions took place. However, a lengthier gap could ultimately prove detrimental to any such project. In Indonesia, government officials often change their position within and among agencies. As a result, if team members from a given mapping project are no longer occupying the same government employee positions when the time comes for the relevant spatial planning revisions to be made, then this is likely to result in a negative outcome.

Recommendation:

When implementing any mapping exercise, it is vital to ensure that the relevant spatial planning was not revised recently. A four- or five-year waiting period could negatively affect the chances of getting data included in the spatial planning. In addition, a large time gap could also render the relevant data outdated.

3 Sexy Facts

When seeking to convince high-ranking government officials of a given position, it has proven very useful to create visual slides for use in presentations which incorporate so-called 'sexy facts'. During our first audience with the regent, we converted the total projected reduction in carbon emissions from megatons of carbon dioxide equivalent to the annual output of a specific number of cars. Similarly, we presented the total area of the fishponds which would be positively affected by the designation of a conservation area as the number of families that would be positively affected. Such numbers speak more to the imagination. During our second audience, the regent had remembered the number of cars mentioned during the first meeting.

Recommendation:

Highly visual presentations and eye-catching numbers can have a highly positive impact on the outcomes of negotiations with high-ranking officials in Indonesia. It is thus recommended that jargon and scientific facts should be converted to facts that speak clearly to the imagination.

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Appendices

Appendix I: Map of Bulungan.

Appendix II: Map of peat extent in North Kalimantan.
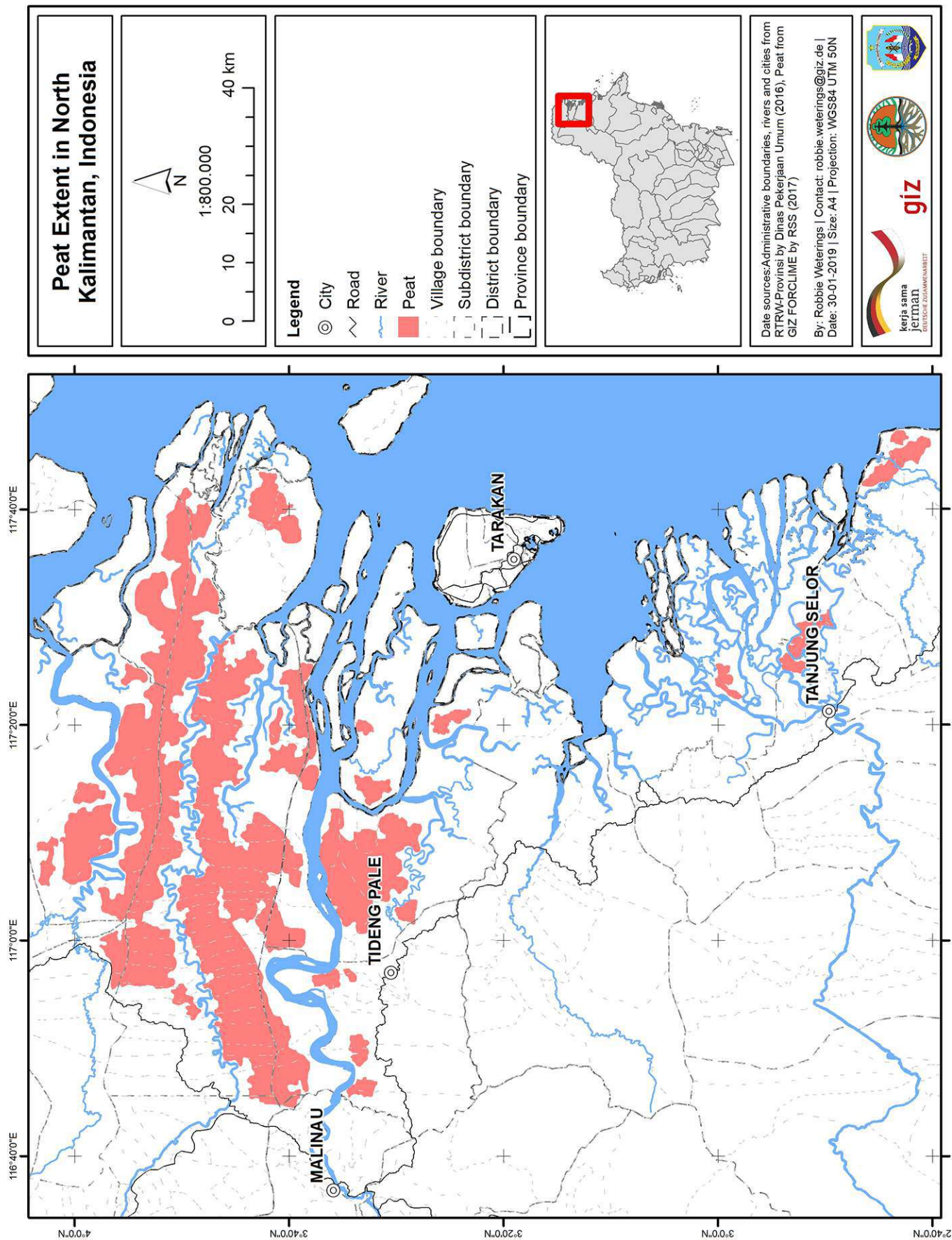
Appendix III: Map of peat depth in Bulungan.
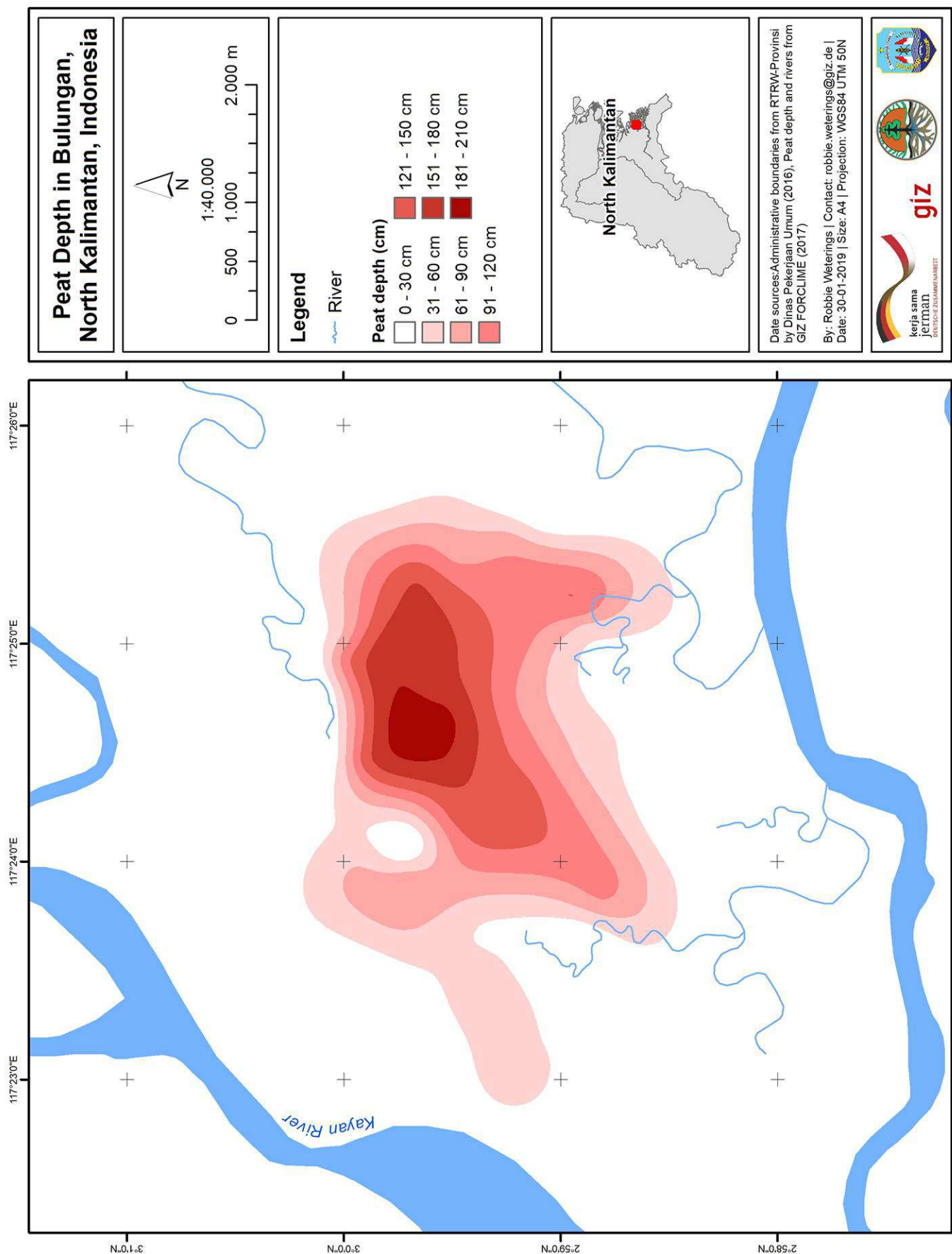
Appendix IV: Proposed conservation area and land use classes within the Food Estate.
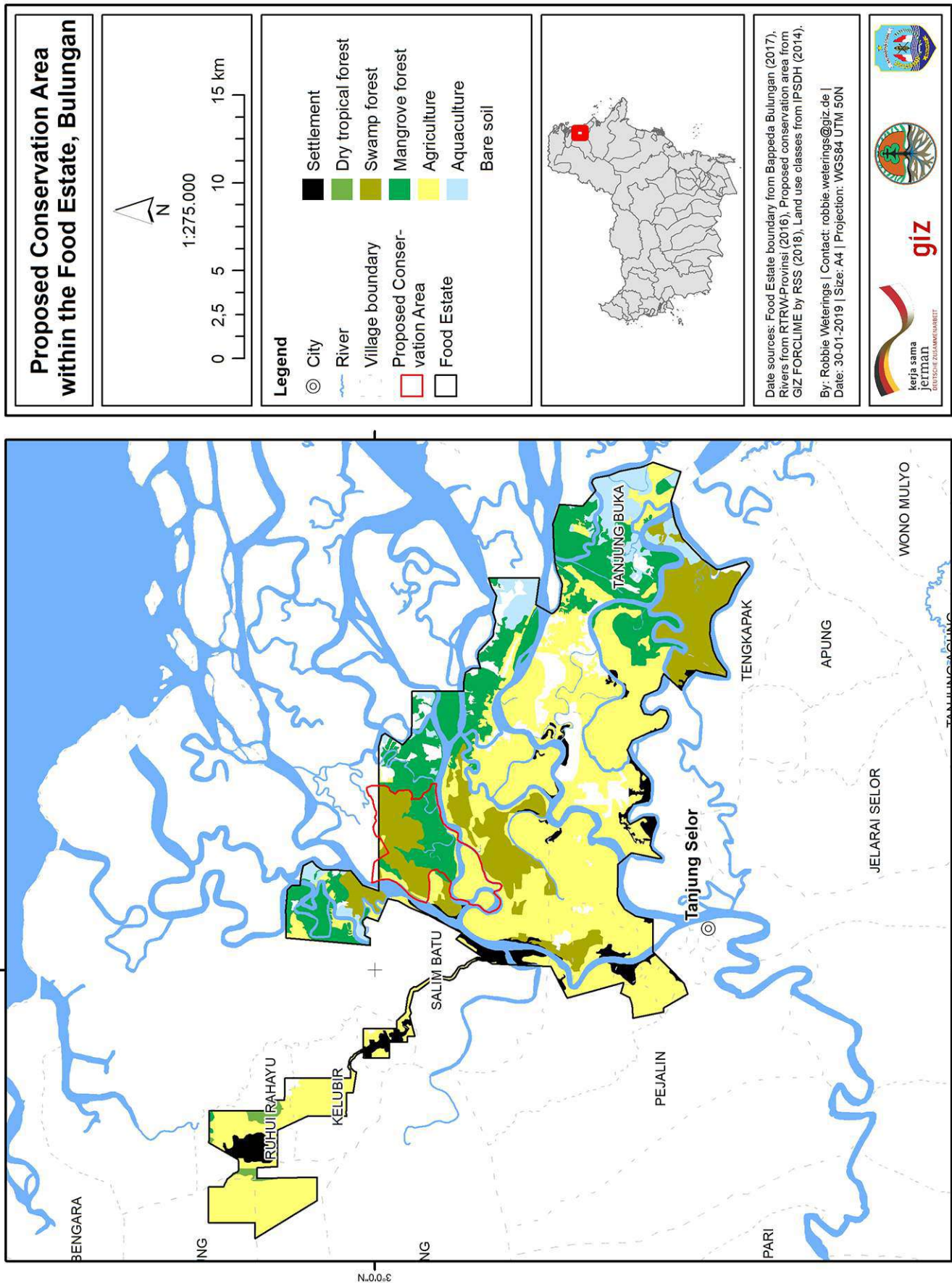
Appendix V: Satellite imagery of the proposed conservation area

Appendices

Appendix I: Map of Bulungan

Location of Bulungan, North Kalimantan, Indonesia

1:1.250.000

N

0 15 30 60 km

Legend

⊚ City
∧ Road
River
☐ Bulungan
Village boundary
Subdistrict boundary
District boundary
Province boundary

Date sources: Land status, Administrative boundaries, Rivers and Cities from RTRW-Provinsi by Dinas Pekerjaan Umum Kalimantan Utara (2016),

By: Robbie Weterings | Contact: robbie.weterings@giz.de | Date: 28-01-2019 | Size: A4 | Projection: WGS84 UTM 50N

TARAKAN

TANJUNG SELOR

TIDENG PALE

MALINAU

Kayan River

Peat Extent in North Kalimantan, Indonesia

1:800.000

0 10 20 40 km

Legend
- ◎ City
- ∧ Road
- River
- ▉ Peat
- Village boundary
- Subdistrict boundary
- District boundary
- Province boundary

Date sources:Administrative boundaries, rivers and cities from RTRW-Provinsi by Dinas Pekerjaan Umum (2016), Peat from GIZ FORCLIME by RSS (2017)

By: Robbie Weterings | Contact: robbie.weterings@giz.de | Date: 30-01-2019 | Size: A4 | Projection: WGS84 UTM 50N

Peat Depth in Bulungan, North Kalimantan, Indonesia

1:40.000

0   500   1.000   2.000 m

Legend

River

Peat depth (cm)

0 – 30 cm	121 – 150 cm
31 – 60 cm	151 – 180 cm
61 – 90 cm	181 – 210 cm
91 – 120 cm	

North Kalimantan

Date sources: Administrative boundaries from RTRW-Provinsi by Dinas Pekerjaan Umum (2016), Peat depth and rivers from GIZ FORCLIME (2017)

By: Robbie Weterings | Contact: robbie.weterings@giz.de | Date: 30-01-2019 | Size: A4 | Projection: WGS84 UTM 50N

Kayan River

Proposed Conservation Area within the Food Estate, Bulungan

1:275.000

0   2,5   5   10   15 km

Legend

- ◎ City
- River
- Village boundary
- Proposed Conservation Area
- Food Estate

- Settlement
- Dry tropical forest
- Swamp forest
- Mangrove forest
- Agriculture
- Aquaculture
- Bare soil

Date sources: Food Estate boundary from Bappeda Bulungan (2017), Rivers from RTRW-Provinsi (2016), Proposed conservation area from GIZ FORCLIME by RSS (2018), Land use classes from IPSDH (2014).

By: Robbie Weterings | Contact: robbie.weterings@giz.de | Date: 30-01-2019 | Size: A4 | Projection: WGS84 UTM 50N

Appendix V: Satelite Imagery of the Proposed Conservation Area

Proposed Conservation Area
Bulungan, North Kalimantan

1:50.000

0   500   1.000   2.000 m

Legend

☐ Proposed Conservation Area

Date sources: Satellite imagery (SPOT7) from Bappeda Provinsi (2016),Proposed conservation area by GIZ FORCLIME (2018)

By: Robbie Weterings | Contact: robbie.weterings@giz.de |
Date: 24-01-2019 | Size: A4 | Projection: WGS84 UTM 50N

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