FACTSHEET and CASE STUDY SUMMARY

Subsidence of peat soils in South-East Asia – Flooding risks in Sarawak

There is an increase in awareness of the carbon emissions resulting from peatland drainage and peat fires. There is in general however a lack of recognition of the link between carbon loss and peatland subsidence, i.e. lowering of the soil surface.

This paper presents the case study of the Rajang Delta in Sarawak, Malaysia where peatland subsidence will cause flooding, rendering 50% and 67% of the land unsuitable for palm oil cultivation after 25 and 50 years respectively. This is 3 to 4 times the size of Singapore.

What is soil subsidence?

Subsidence is the lowering of the soil surface as a result of physical compression of the peat and loss of carbon due to oxidation and erosion. Peat soils comprise of 10% accumulated organic materials and 90% water. When drained, the peat oxidizes and all peat above the drainage level will eventually be lost (see Figure 1).

In the tropics the process of subsidence after drainage is very fast due to high temperatures. Flood risks are also more severe because of high precipitation. Continuous peatland subsidence may eventually result in increased flooding and possibly in production loss in agriculture and silviculture, as shown in studies in South-east Asia and elsewhere (Hooijer *et al.* 2012).

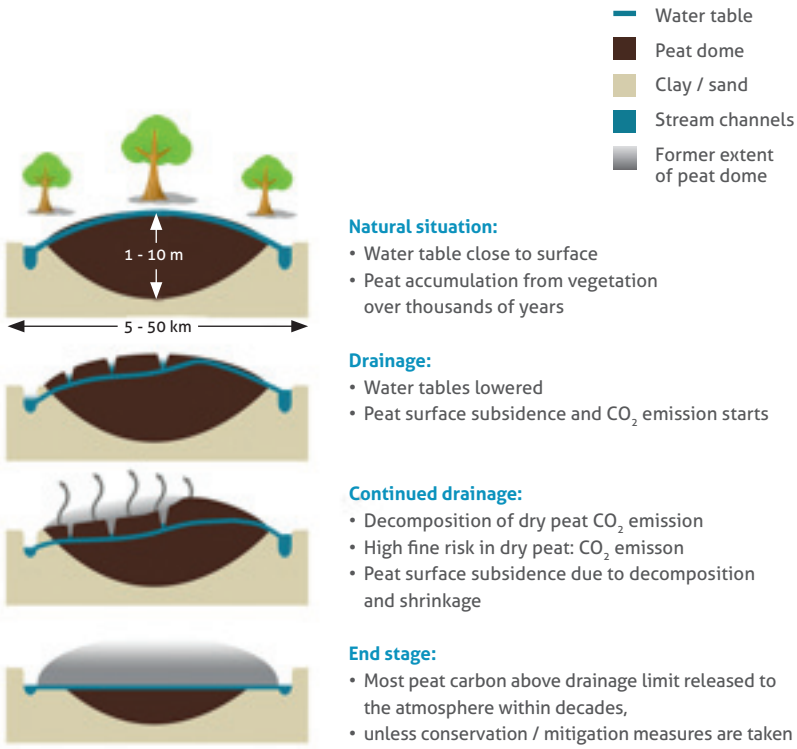

Figure 1. Cross-section of a peat dome in natural situation and after drainage (Hooijer *et al.* 2006/2010).

Flooded palm oil plantation due to peat soil subsidence. Photo by Deltares

Flooded oil palm plantation in Aceh. Photo by BPKEL and Deltares, 2011

What can be done to mitigate further subsidence and resulting flooding in the tropics and instead create sustainable peat landscapes?

Radical change in land use planning and gradual phasing out of current unsustainable land-uses on peat

In South-east Asia the land conversion of peat swamp forests started relatively recent, mostly for palm oil and pulp plantations and other drainage dependent agricultural land-uses. In 2010, 20% of the peatlands in South-east Asia were occupied by palm oil and pulp plantations and only 34% remained under (mostly degraded) forest cover. Extrapolating past trends, the total area covered by plantations could double or even triple by 2020 (Miettinen *et al.* 2012).

If current business as usual land-use planning for development of drainage-based plantations on peat is not radically changed and if current unsustainable land uses on peatlands will not be phased out, large-scale subsidence and flooding of lowland peatlands will become inevitable with tremendous social, ecological and economic consequences.

Recommendations for sustainable peat landscapes

- No (new) drainage based plantations on peat. There is a need for a stronger Moratorium on conversion of peatlands and other forests in Indonesia and a similar moratorium should be considered for Malaysia;
- Issuance of a Government Regulation limiting drainage use in forest and plantation concessions in peatlands;
- Conservation of all remaining tropical peat swamp forests in view of their valuable ecosystem services (including carbon storage, water regulation, biodiversity);
- As an interim measure towards permanent solutions, existing agriculture and plantations should minimise drainage, bringing the water level up, curb the application of fertilizers and maintain a permanent soil cover to reduce the rate of peat soil degradation and enhance peat soil protection;
- In the mid and long term, degraded peatlands should be rewetted and rehabilitated, either to natural habitat or to alternative land-uses like paludiculture (cultivation of commercially interesting crops on rewetted peatlands). Indigenous peatland species like Tengkawan (Ilipe Nut), Jelutung (Asian latex) and Sago (starch) can yield an income for local people and provide opportunities for global marketing;
- Plantation companies will eventually have to abandon their peat-based plantations or change their production systems: they can either move to suitable mineral soils areas, or must switch to production systems that require no drainage;
- Implementation of environmental and social safeguards in peatland development, restoration and conservation.

Rajang delta case study summary

Future outlook for subsidence and flooding in Sarawak resulting from peatland drainage

Introduction

This case study shows that peatland subsidence will flood large parts of the Rajang Delta in Sarawak which will make palm oil cultivation impossible. We therefore argue that long-term sustainable use of these peatlands will require planning of land-swaps of palm plantations to mineral soils and the rewetting of peatlands for suitable economic alternatives.

Subsidence rates and future flooding projections

A subsidence rate of 3.5 cm per year is used which presents a conservative flooding calculation. The flooding projections are shown in figure 2 that:

- 50% and 67% of the land will be affected by some form of flooding or drainability loss after 25 and 50 years respectively. This is 3 to 4 times the size of Singapore.
- After 100 years, only 7.1% of the land is still drainable by gravity but suitability for palm oil cultivation is questionable.

Flooding risks

Subsidence and the related flood risk is a well-known and inevitable phenomenon in all places in the world where lowland peatlands have been converted to drainage-dependent land-uses. Examples include the UK (Somerset), USA (Sacramento Delta, Everglades), northern Germany, Denmark and the Netherlands where a large part of the highly populated west is situated below sea-level as a result of soil subsidence.

Research results peat soil subsidence SE Asia

In western Indonesia (namely Sumatra and Kalimantan) and Malaysia many of the peat swamp forests have been drained for palm oil or pulp wood plantations. In the first five years after drainage, peatland subsidence is typically 1 to 2 metres. In subsequent years, this stabilizes to a constant 3 to 5 cm per year, resulting in a subsidence of 2-3 metres in 25 years and 4-5 meters within 100 years.

Wetlands International works with Deltares in better quantifying the peatland subsidence problem in SE Asia. These insights in peatland drainage impacts and subsidence rates are largely taken from Hooijer *et al.* (2010) and Hooijer *et al.* (2012).

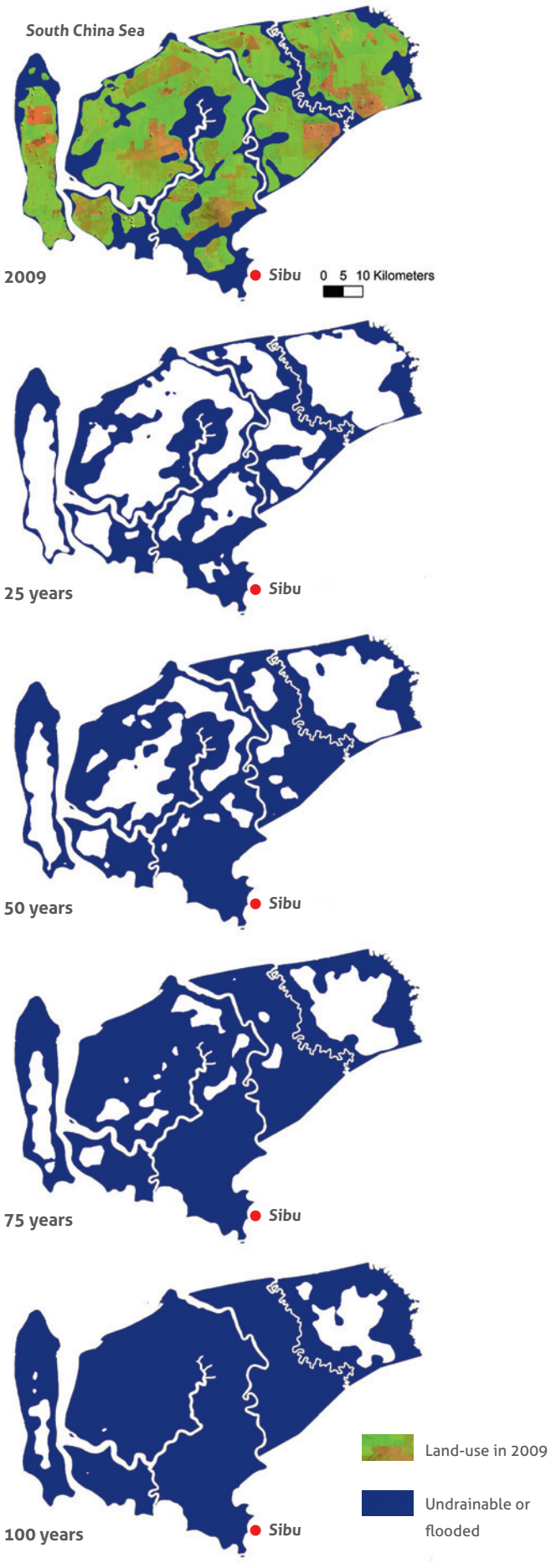

Figure 2. Flood extent projection for 0, 25, 50, 75, and 100 years applying a subsidence rate of 3.5 cm per year (likely scenario) after 2009. Blue areas will become unsuitable for palm oil production. Progressive subsidence will also reduce options for current alternatives. Source: Deltares, 2014

The case study area

The Rajang Delta peatlands in Sarawak, Malaysia cover almost 395,700 ha (see figure 3). These peatlands are generally more than three meters deep and relatively low in elevation, not exceeding 6.5m above Main Sea Level (MSL) (see figure 4). Since early 1990s, large areas have been converted to oil palm plantations and cover at least 46% in June 2014. The plantations are drained to enable the cultivation of palm oil trees which also drains the surrounding peatlands.

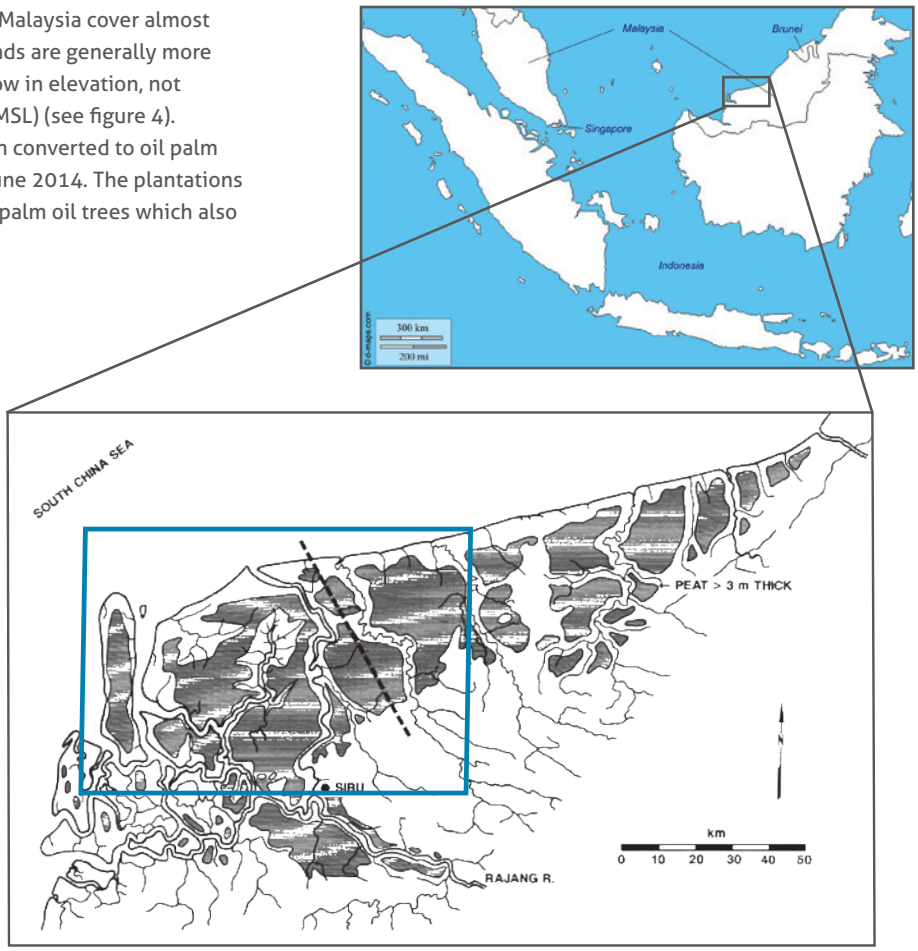

Figure 3. Full extent of peat with a thickness over 3 m (grey area) in and around the Rajang Delta. The blue box shows the outline of the current study area. The black dotted line separates the Rajang Delta system in the West from the Coastal Plain system in the East. (Adapted from Staub and Gastaldo (2003)).

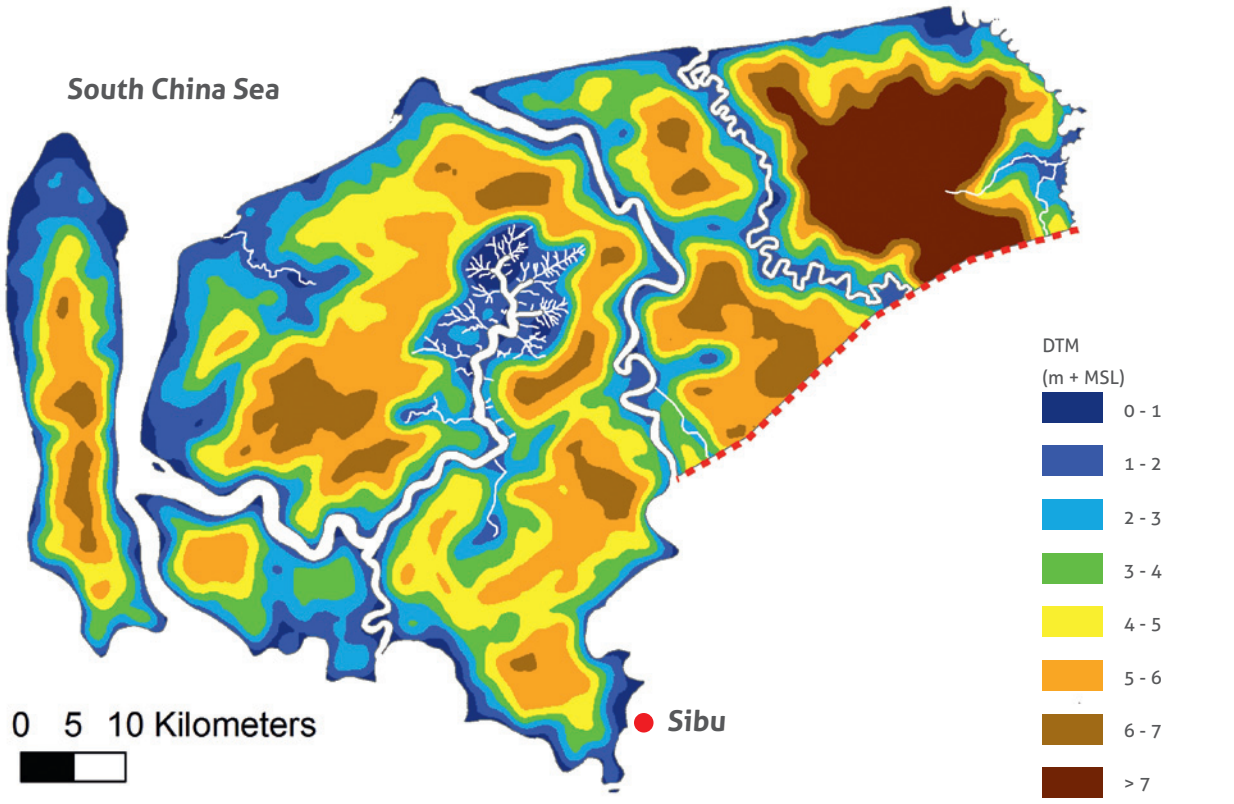

Figure 4. Digital Terrain Model (DTM) for the study area. Source: Deltares 2014.

Flooding history

The Sarawak coastal area is known to be exceptionally flood prone, especially around the Rajang Delta. Highest river flood levels at Sibu can exceed four metres above MSL. This is two metres above the 'normal' river level, which is defined as the local 'danger level' for flood mitigation and evacuation. The suitability of these lands for drainage-based agriculture has always been contested, including by the Department of Agriculture of Sarawak, 1982 (see figure 5;). We predict that this flooding will increase due to peatland subsidence caused by the current drainage-based land-uses.

Conclusion

It is expected that crop production will gradually decline, but not end immediately. Drainage will become increasingly problematic, especially in the wet season. As a result plantations will be increasingly abandoned. While the effect of subsidence in the coming 25 years will require investments in management costs, within 50 years much or even most of the area is expected to become unsuitable for oil palm plantations. These are conservative estimates and other processes such as fires may speed up subsidence rates which, together with sea level rise and peak flood conditions, will increase the water level and flood more land.

Flooding in the Matu-Daru district, in the NW part of the study area near the coast. Note that the water is mostly 'tea coloured', indicating it partly originates from the peatlands further inland but cannot quickly be discharged to sea because of high sea levels. Flooding in this area cannot easily be mitigated.

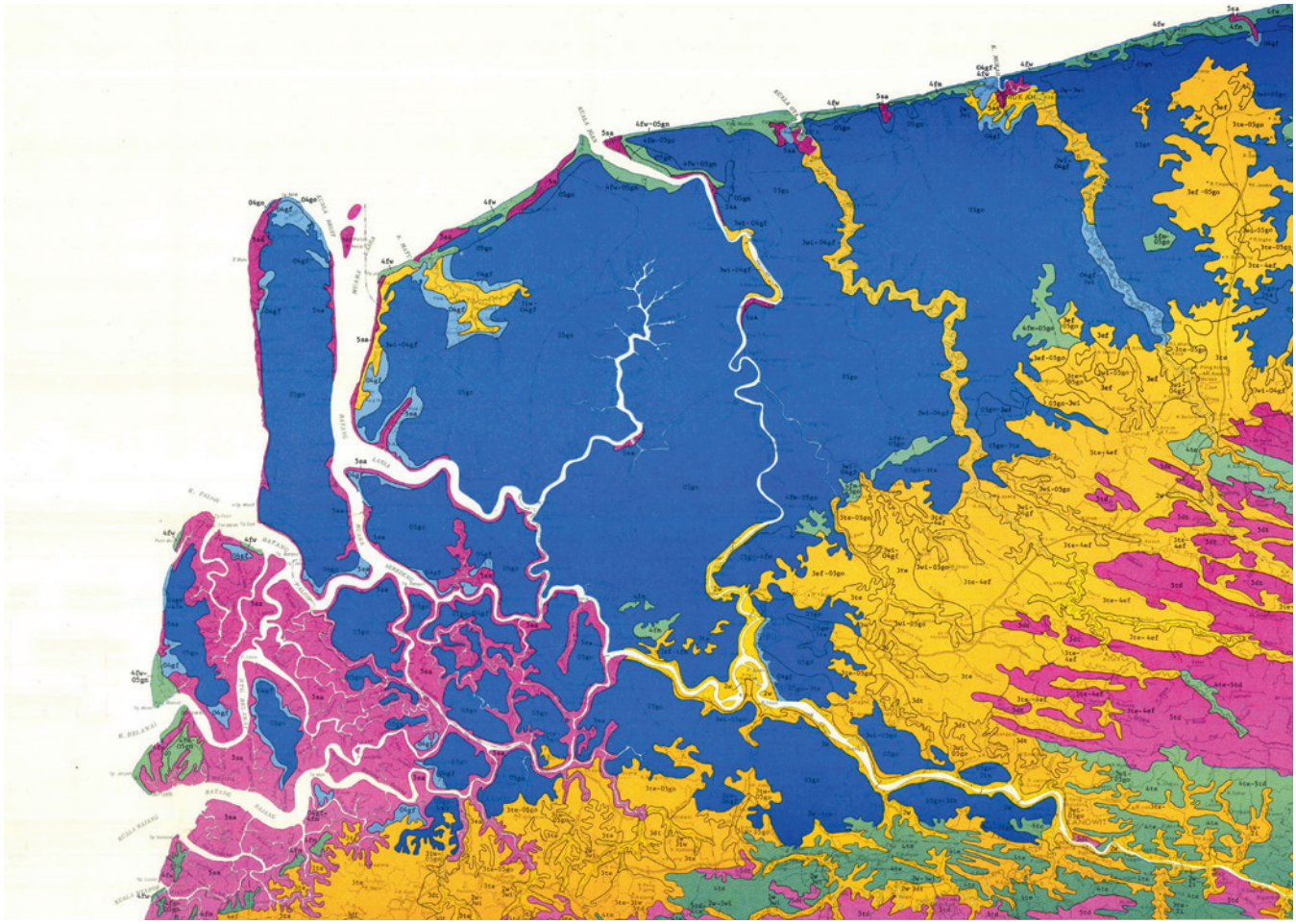

Figure 5. Map of 'agriculture capability' for the study area, as published by the Department of Agriculture of Sarawak (1982). The dark blue area presents peat and is described as "LAND COMPRISING ORGANIC SOILS WITH SUCH SEVERE LIMITATIONS THAT AGRICULTURE IS NOT FEASIBLE."

Join our efforts

Wetlands International is working with many local and international partners, from government, industry, science and NGOs to raise awareness on the issues of unsustainable peatland development and management. All stakeholders should ensure that land-use planning will take account of the huge environmental and economic impacts of peatland drainage in terms of greenhouse gas emissions, subsidence and the inevitable increasing flood risks. We advocate for the conservation of remaining peat swamp forests in view of their tremendous value as carbon stores, water regulation, biodiversity and natural productivity. Responsible entrepreneurs should plan the phasing-out of existing unsustainable land-use on peat to prevent extensive lowland landscapes in South-east Asia to become disaster areas. Economic alternatives need to be piloted and up-scaled by industry and communities, including paludiculture. Government needs to establish a conducive framework of policies and legislation that prevents further unsustainable development and encourages climate-smart land-use in peatland landscapes.

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