Land Subsidence

Land subsidence is a phenomenon of sudden sinking or gradual downward settling of the ground’s surface towards the reference point. This condition is commonly occurs in coastal cities, coastal peat areas and coastal oil and gas exploitation areas. In Indonesia, at least 21 provinces and 132 districts / cities are now indicated to have land subsidence, even for several locations on the North Coast of Java and East Sumatra Coast, have been recorded for having experience on land subsidence and are exposed to the its impact, i.e Tidal flood. The rough calculation of losses that measured only from the adaptation costs for repairing roads, bridges and settlements in northern coast of Java shows that the potential losses caused by land subsidence for each year is IDR 619 Trillion. Meanwhile, for the potential loss of residential buildings in the subsided peat area is reaching around IDR 158 trillion, this figure have not yet included other economic losses parameters.

The average rate of land subsidence in Indonesia’s coastal lowlands are varies from 1-20 cm / year. In some locations, such as Rangsang island, Riau, subsidence is also followed by coastal erosion at rates 30 meters / year. ITB monitoring results show that in the north coast of Java, at least 16 cities / districts experienced subsidence with impacted total area is reaching 11,500 hectares, while indications of subsidence in the peat ecosystem is reached 2.6 million hectares. High rates of subsidence has hampered conservation and rehabilitation efforts in the Coastal Zone and have the potential to eliminate Strategic Economic Zones, such as the Java North Coast Region, and eliminate tropical peat ecosystems such as the East Coast of Sumatra. For border and outer islands areas, such as Meranti Islands, Riau, this condition creates a weak point in the nation and state defence effort.

To avoid greater losses in the future, efforts to stop or reduce the rate of subsidence, as well as to prevent and handle disasters caused by subsidence are very urgent. For this reason, the Coordinating Ministry of Maritime Affairs, together with Yayasan Lahan Basah (Wetlands International Indonesia), the Bandung Institute of Technology (ITB), and the Working Group for Land subsidence roadmap development jointly develop The Mitigation and Adaptation Road Map of Land Subsidence in the Coastal Lowlands of Indonesia. The Road Map has been prepared to be used as a reference and guideline for implementing the mitigation and adaptation program that involves all relevant stakeholders.

Summary
Mitigation and Adaptation Road Map of Land Subsidence in Lowland Coastal Areas in Indonesia
Potential Losses caused by Land Subsidence in peat or non-peat coastal areas

**Physical Aspect**

1. Loss of coastal areas;
2. Loss of land resources;
3. Damage to infrastructure;
4. Increased depth and frequency of floods;
5. Sea water intrusion;
6. Increased exposure to extreme waves and/or tsunamis;
7. Damage to peatland ecosystems that are integrated with freshwater ecosystems, the function of peat regulation in flowing fresh water naturally into the surrounding river or swamp ecosystem will be disturbed/damaged;
8. Declining Quality of the Environment;
9. Greenhouse gas (GHG) emissions increase due to loss of mangrove and/or coastal peat ecosystems.

**Social Aspect**

Communities lose coastal land and or peatlands based livelihoods.

**Economic Aspect**

1. Increase of Land management cost;
2. Increase of water consumption cost;
3. Costs incurred by disasters including economic losses such as losses from low productivity, adaptation costs and relocation costs.

Map of potential land subsidence area in Indonesia (Andreas et al. 2019)

Problem of land subsidence in Indonesia
General framework of mitigation and adaptation roadmap of land subsidence in coastal lowland of Indonesia

**LAND SUBSIDENCE TRIGGERED DISASTER**
Already occurs with alarming impact

**LAND SUBSIDENCE RISK MAPPING**
Sporadic, no national wide map, limited to several locations locally

**LAND SUBSIDENCE MITIGATION AND ADAPTATION**
Sporadic, no comprehensive program, no leading sector concern to handle the issue

**MONITORING SYSTEM**
No monitoring system at national level, only limited to several location

**LAND SUBSIDENCE MAINSTREAMING IN TO SPATIAL PLANNING**
Has no systematically programmed

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1. Establish an authorized institution/coordinator for the mitigation and adaptation of land subsidence program implementation along with coordinating strategies between institutions and its legal basis;
2. Develop critical groundwater basins and the risk of land subsidence disasters map;
3. Monitor the rate of land subsidence in coastal; peat and oil and gas areas;
4. Short term efforts (Adaptation);
5. Long term efforts (Mitigation) through land subsidence based spatial zoning approaches, water resource management, peatland conservation, environmentally friendly exploitation and high-tech approaches;
6. Awareness raising and capacity building;
7. Law enforcement of the utilization of ground water and spatial planning.

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1. An authorized institution/coordinators of the implementation of mitigation and adaptation of land subsidence in place on a clear legal and policy basis;
2. Critical groundwater basins and land subsidence disaster risk map are in place and keep updated;
3. Land subsidence rate monitoring system is in place and operationalized;
4. Optimal adaptation system is in place and implemented;
5. Maximum elimination or reduction of land subsidence rate in Indonesia;
6. Success in awareness raising and capacity building;
7. Legislation of regulation for law enforcement on groundwater utilization and spatial planning.

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**Time Frame of The Roadmap**

<table>
<thead>
<tr>
<th>2019</th>
<th>2020</th>
<th>2020</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2029</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of governance system, legal base and coordination mechanism</td>
<td>Critical ground water basins and land subsidence risk mapping</td>
<td>Updating</td>
<td>Land subsidence monitoring</td>
<td>Short term measure (i.e. Building dam, building base escalation, etc.)</td>
<td>Long term measures (water management, peatland conservation, land subsidence based spatial planning, sustainable mining exploitation)</td>
<td>Awareness raising, capacity building and law enforcement</td>
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</tbody>
</table>
Strategies


1.1 Coordinating mechanism between the relevant sector ministries for mitigation and adaptation to land subsidence is in place;
1.2 Technical institutional forms for implementing mitigation and adaptation of land subsidence is agreed;
1.3 Legal basis documents/ institutional policies for implementing mitigation and adaptation of land subsidence is developed;
1.4 Technical institutions for the mitigation and adaptation of land subsidence is established and operationalized.


2.1 Land subsidence in coastal lowlands in Indonesia risk's map is developed;
2.2 Land subsidence in coastal lowlands in Indonesia risk map is regularly updated.


3.1. Groundwater basin monitoring programs, and land subsidence monitoring in coastal cities are in place by involving the central government, regional governments and CSR;
3.2. Land Subsidence monitoring in priority coastal city locations is implemented;
3.3. Land subsidence monitoring in indicated coastal city locations is implemented;
3.4. Land subsidence monitoring programs in coastal peat areas is in place by involving the central government, regional governments, and CSR systems from private parties (HTI companies, oil palm plantations, etc.);
3.5. Land subsidence monitoring in priority peat areas is implemented;
3.6. Land Subsidence monitoring in indicated coastal peat is implemented;
3.7. Land subsidence monitoring programs in the oil and gas exploitation area is in place by involving the K3S team through SKK-Migas and or other scenarios such as CSR from the private sector;
3.8. Land Subsidence monitoring program in the priority oil and gas exploitation area is implemented.

**Strategy 4. Develop Concepts, Standard Operating Procedures (SOPs) and Implement Short-Term Solutions / Adaptations for Disaster of Land Subsidence that have Occurred (2019-2024)**

4.1. The concept and SOP of short-term solutions / adaptations of land subsidence disasters are developed and socialized;
4.2. Short-term solutions/ adaptations are implemented;
4.3. The implementation of short-term solutions/ adaptations are monitored.

**Strategy 5. Develop and Implement the Concept of Land Subsidence Prevention (Mitigation) through Spatial Planning Approach, Water Management, Peat Conservation and High-tech Environmentally Friendly Oil and Gas Exploitation Activities (2010-2029)**

5.1 Guidelines for the integration of land subsidence into Spatial Planning is developed;
5.2. Priority areas for integration of land subsidence into Spatial Planning are identified;
5.3 Land subsidence is mainstreamed into spatial planning;
5.4. Water management based mitigation program plan is developed;
5.5 Priority areas for water management based mitigation programs are identified;
5.6 Water management based mitigation program is implemented;
5.7. Plan for mitigation of land subsidence based on peatland conservation is developed;
5.8. Priority areas for peatland conservation-based land subsidence mitigation programs are identified;
5.9. Land subsidence mitigation programs based on peatland conservation is implemented;
5.10. Land subsidence mitigation program plans through environmentally friendly and high-tech oil and gas exploitation programs is developed;
5.11. Priority areas for oil and gas exploitation programs that are environmentally friendly and high-tech are identified;
5.12. Oil and gas exploitation programs that are environmentally friendly and high-tech is implemented.


6.1. The awareness raising and capacity building programs in dealing with land subsides are arranged and implemented.


7.1. Regulations and institutions for Law Enforcement related to the Utilization of Groundwater and Spatial Planning are in place;
7.2. Policies and regulations and institutions for Law Enforcement related to the Utilization of Groundwater and Spatial Planning are implemented and operationalized.