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# MITIGASI LAND SUBSIDENCE MELALUI PENERAPAN RAIN WATER HARVESTING DAN PENGUATAN PERAN ANTAR AKTOR

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# INTRODUKSI

## Definisi *Land Subsidence*

Proses deformasi yang terjadi secara relatif, bertahap, atau tiba-tiba pada setiap lapisan tanah lunak, seperti lapisan geoid dan elipsoid , yang umumnya dibentuk oleh lapisan tanah liat atau lanau dengan tingkat permeabilitas rendah dan kedap air

(Ishii *et al.*, 1970; *The United State Geological Survey*, 2019)

# FAKTOR PEMICU

## FAKTOR ANTROPOGENIK

meningkatkan laju l*and subsidence* secara signifikan

- Ekstraksi Air Tanah
- Ekstraksi Minyak dan Gas
- Aktivitas Pertambangan
- Beban Konstruksi Bangunan

## FAKTOR ALAMI

- Pergerakan Tektonik
- Konsolidasi Tanah Alami
- Retakan Lempeng Bumi

***POLICY MAKING***

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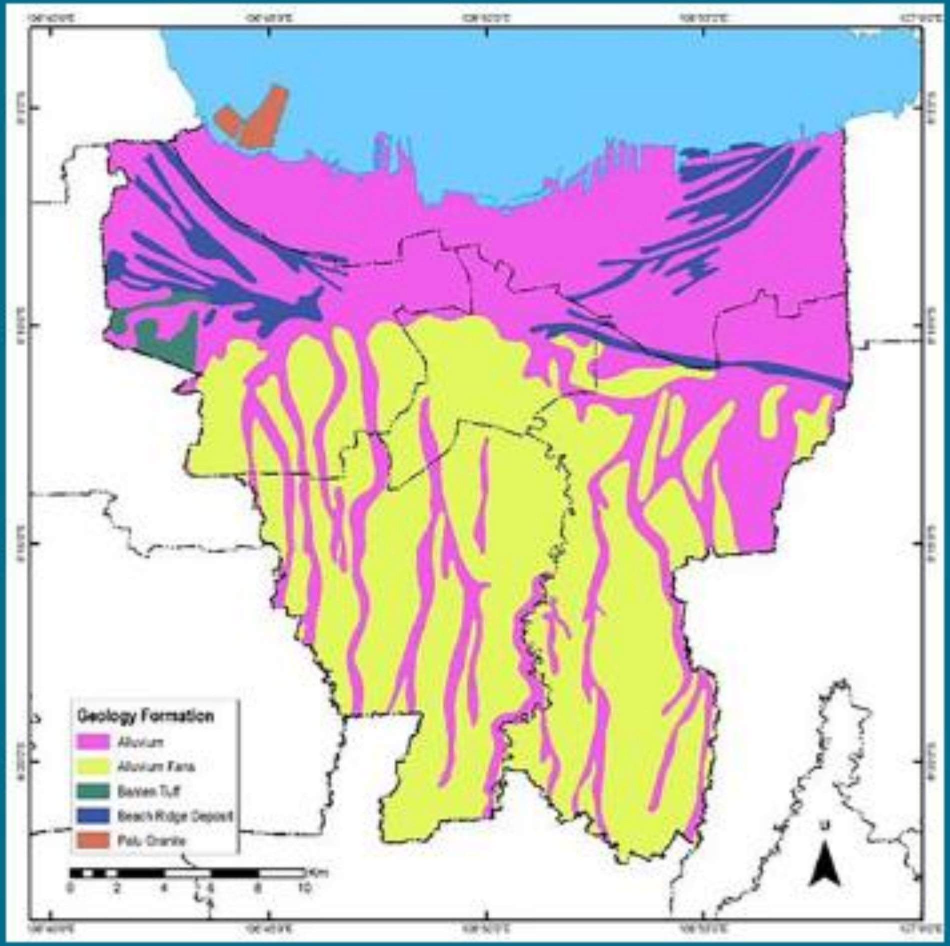
# JAKARTA *LAND SUBSIDENCE*

# Pengantar

- **1982** — Pertama Kali disorot
- **1993** — Pertama Kali diteliti; Penurunan 1-9 cm/tahun
- **1997** — Penurunan Meningkat; 1-25 cm/tahun
- **2011** — Penurunan Meningkat Kembali; 1-28 cm/tahun (total 116 cm)
- **JAKARTA UTARA** — SEBAGAI WILAYAH DENGAN PENURUNAN TERTINGGI

# Karakteristik Jakarta Utara




Memiliki 4 jenis bentang alam:

*Marine-Origin* (Utara)
*Beach-Ridge* (Barat & Timur Laut)
Rawa & Rawa Bakau (Pinggiran Pantai)
*Former River Channel* (Garis Pantai)

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| No. | Regional | Characteristics |
|---|---|---|
| 1. | Unit Area 1 | This area features coastal bunds with a typology landscape in the form of embankments that are parallel to the shoreline and have relatively flat surface contours. It is formed by fine- and coarse-grained sand deposits and sandy slap with a groundwater depth of 0.5–1.5 m from the surrounding ground surface. It is also a center of sedimentation and erosion, which occurs around the Pantai Kapuk and Citarum Estuary on the east side. |
| 2. | Unit Area 2 | This area is formed by the distribution of river deposits of loose sand and gravel. Shallow groundwater in this area is found at a depth of 2–5m from the ground surface, while compressed groundwater is found at a depth of 60–120m. These characteristics have the potential to cause flooding. |
| 3. | Unit Area 3 | This area is coastal lowland with an altitude of 0–2m above sea level. It is formed by flood and swamp deposits in the form of soft sandy loam and gray–black in color. Shallow groundwater is generally brackish, whereas deep groundwater is found in the middle and deep aquifers. |

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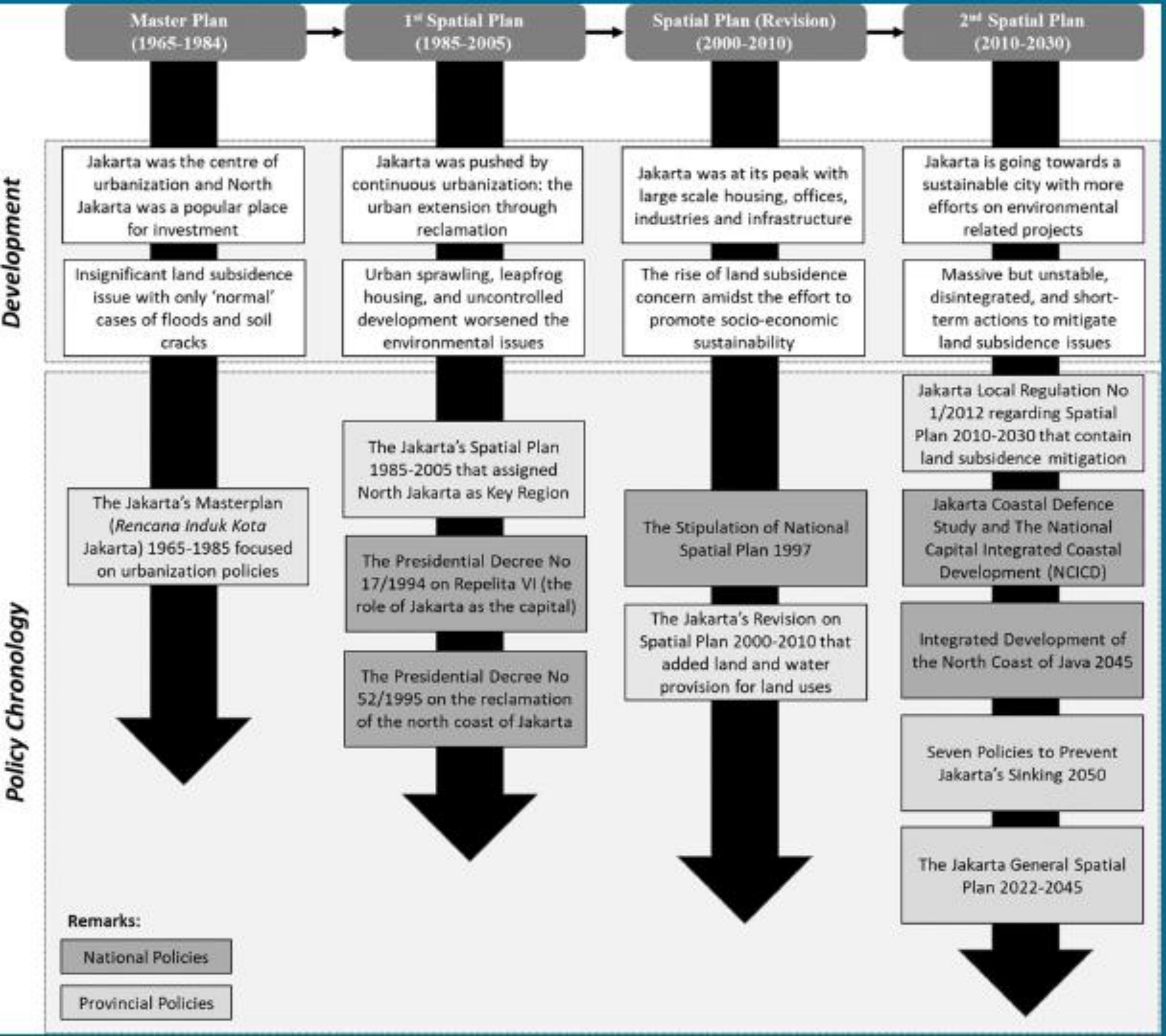
# Three Types of North Jakarta Environmental Geological Unit Areas

*(The 1965 DKI Jakarta Regional Environmental Geological Investigation Report).*




# LAND SUBSIDENCE & SEJARAH KEBIJAKAN PEMBANGUNAN

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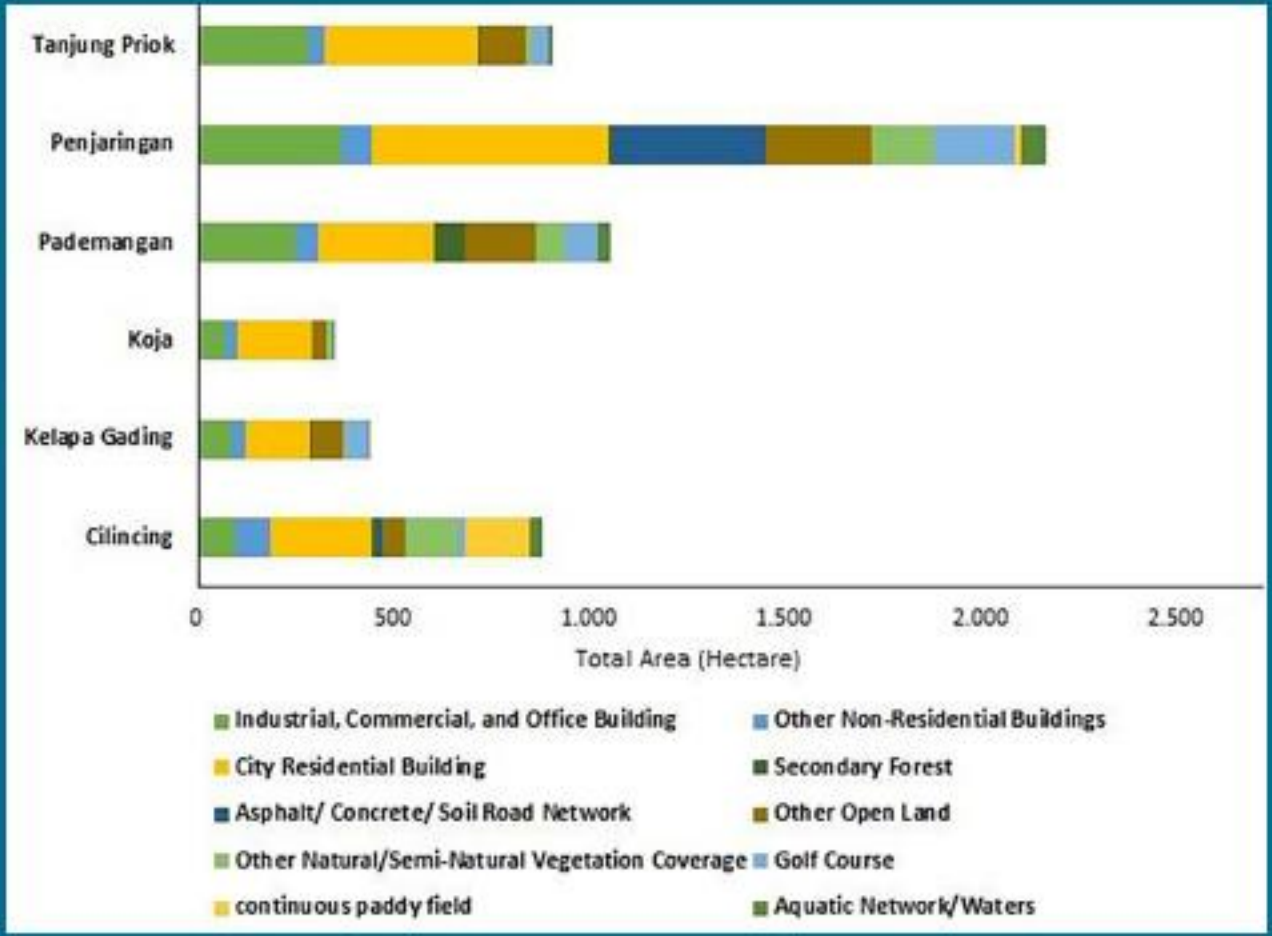
| | | | |
|---|---|---|---|
| 1. | Infrastructure | Cracking of permanent constructions and roads<br>Tilting of houses and buildings<br>Sinking of houses and buildings<br>Breaking of underground pipelines and utilities | Malfunction of the sewerage and drainage system |
| 2. | Economic | – | Increase in the maintenance cost of infrastructure<br>Decrease in land and property values<br>Abandoned buildings and facilities<br>Disruption of economic activities |
| 3. | Environment | – | Changes in river, canal, and drain flow systems<br>Frequent coastal flooding<br>Wider expansion of flooding areas<br>Inundated areas and infrastructure<br>Increase in inland seawater intrusion<br>Deterioration in the quality of environmental conditions |

# DAMPAK *LAND SUBSIDENCE* PADA PEMABNGUNAN DI JAKARTA UTARA

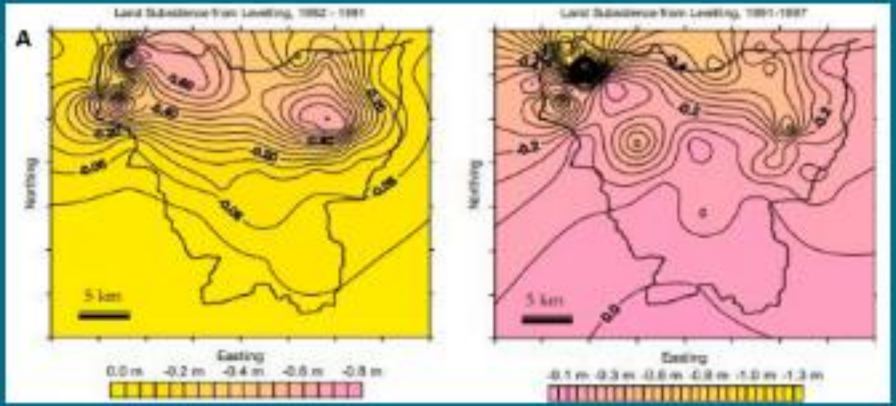
(Hasibuan *et al.*, 2023)

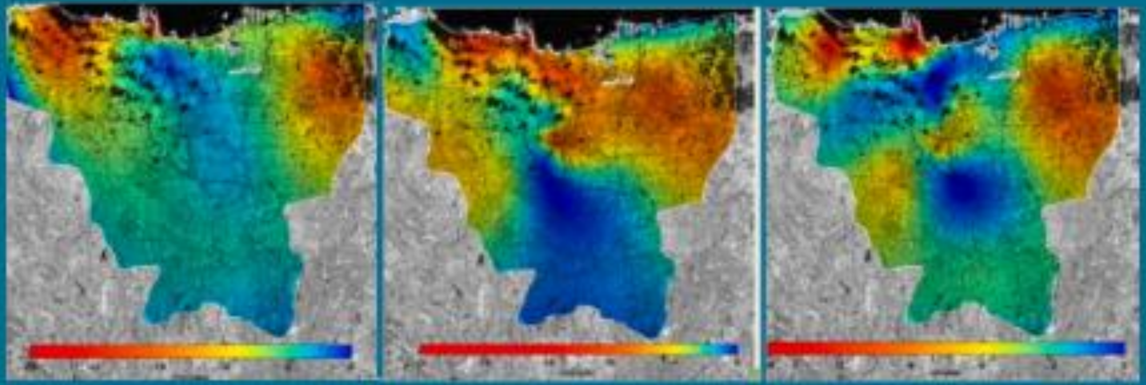



(Hasibuan *et al.*, 2023)

1982-1991

1991-1997



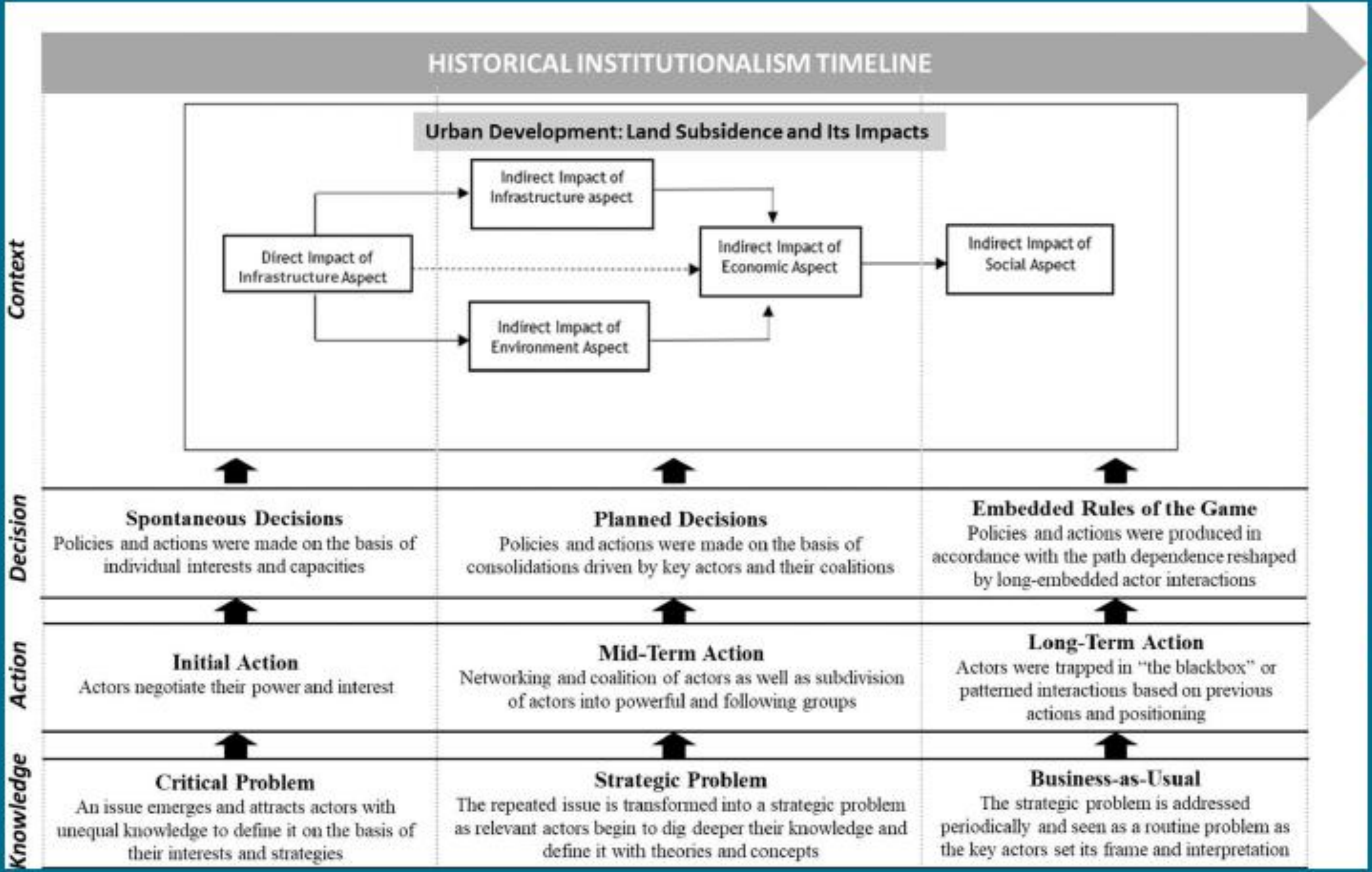
2007-2008

2008-2009

2009-2010

(Abidin *et al.*, 2001; 2005; 2008; 2008b)

# RESPON LAND SUBSIDENCE



# MITIGASI *LAND SUBSIDENCE* MELALUI RWH

# Tantangan Pemenuhan Air Bersih

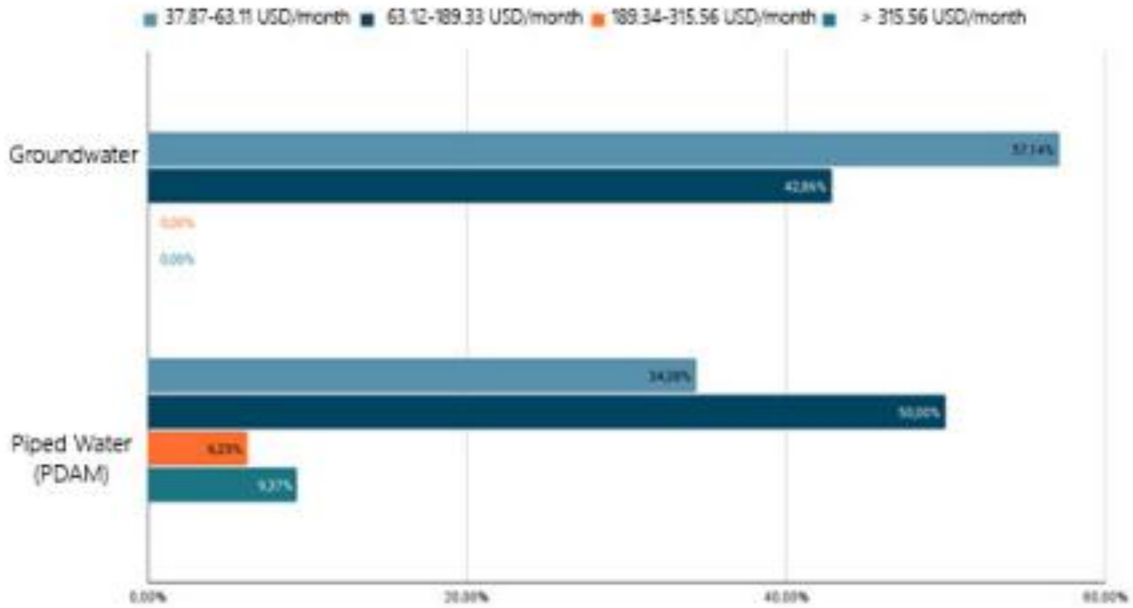
| Fulfillment challenges | The main water sources | | | |
|---|---|---|---|---|
| | Pipe Water | | Groundwater | |
| | n | % | n | % |
| Quantity limitation | 30 | 93.75 | 8 | 57.14 |
| Low quality | 0 | 0 | 5 | 35.71 |
| Expensive cost | 2 | 6.25 | 1 | 7.15 |

(Hasibuan *et al.*, 2024)

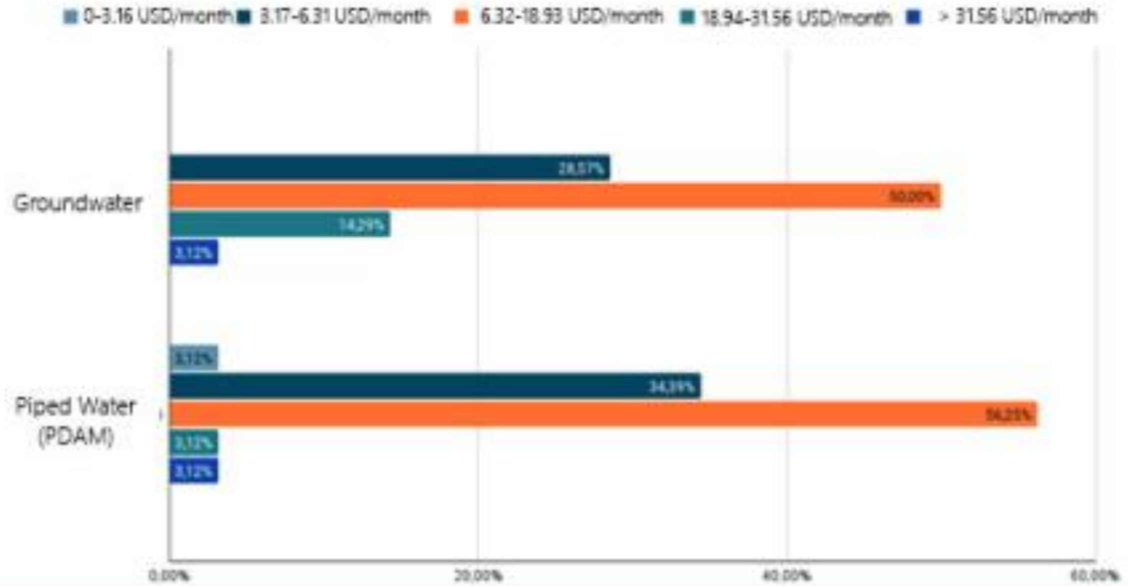
| Difficulty factors | | Total | |
|---|---|---|---|
| | | n | % |
| Limited availability | | 17 | 77.27 |
| 1. | Limited piped water | 8 | 47.06 |
| 2. | The lack operasionalization of piped water | 6 | 35.29 |
| 3. | Dry wells | 2 | 11.76 |
| 4. | Unequal distribution of piped water | 1 | 5.89 |
| Unaffordable prices | | 3 | 13.64 |
| 1. | Cost allocation 23% of monthly income | 1 | 33.33 |
| 2. | Cost allocation 10% of monthly income | 2 | 66.67 |
| Poor quality of main wáter souce | | 2 | 9.09 |
| 1. | Piped water | 0 | 0 |
| 2. | Ground water | 2 | 100.00 |

(Hasibuan *et al.*, 2024)

## Income per Month




## Clean Water Expenses per Month

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**Pengguna pada kelompok eknomi menengah bawah harus menyisihkan 23% pendapatan per bulan untuk mengkases air bersih**

(Hasibuan *et al.*, 2024)

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# 46, 62%

**Warga di sekitar wilayah penerapan teknologi memanfaatkan RWH sebagai sumber air bersih alternativ**

(Hasibuan *et al.*, 2024)

# Faktor Pemicu

| Variable | B | Standard error (SE) | Wald | Sig. | Exp(B) | Nagelkerke R square | -2 Log likelihood |
|---|---|---|---|---|---|---|---|
| Ability to meet the needs | 1.323 | 0.581 | 5.177 | 0.023 | 3.754 | 0.223 | 37.489 |
| Constant | -5.253 | 1.885 | 7.767 | 0.005 | 0.005 | | |
| The perceived benefits of RWH | 1.281 | 0.920 | 1.939 | 0.164 | 3.600 | | |
| The ease of operating RWH | 0.117 | 0.737 | 0.025 | 0.874 | 1.124 | | |
| The accessibility of RWH | 0.369 | 0.538 | 0.470 | 0.493 | 1.446 | | |

Individu yang mempersepsikan RWH mampu memenuhi kebutuhannya akan memiliki kecenderungan 3,754 kali lebih besar untuk mengadopsi teknologi tersebut dibandingkan dengan mereka yang tidak mempersepsikan demikian

Persepsi terhadapa RWH sebagai solusi pemenuhan sumber air bersih yang layak memegang peranan penting dalam proses pengambilan keputusan untuk menerapkan teknologi tersebut

(Hasibuan *et al.*, 2024)

# Karakteristik Pengguna RWH

| User characteristics | Utilization of RWH | | | |
|---|---|---|---|---|
| | Yes | | No | |
| | n | % | n | % |
| *The main water sources* | | | | |
| Piped water (PDAM) | 51 | 73.91 | 54 | 68.35 |
| Groundwater (Drill and dug wells) | 18 | 26.09 | 25 | 31.65 |
| Family members | | | | |
| 1-3 persons | 20 | 28.99 | 18 | 22.78 |
| 4-6 persons | 44 | 63.77 | 54 | 68.35 |
| 7-10 persons | 4 | 5.80 | 7 | 8.87 |
| > 10 persons | 1 | 1.44 | 0 | 0 |
| *Ease of access* | | | | |
| Easy | 23 | 33.33 | 39 | 49.37 |
| Difficult | 46 | 66.67 | 40 | 50.63 |

(Hasibuan *et al.*, 2024)

| No. | Parameters | Unit | Result | Quality standard |
|---|---|---|---|---|
| | | **Physic criteria** | | |
| **Groundwater** | | | | |
| 1. | Temperature | Degree Celsius (°C) | 26.3 | - |
| 2. | TDS | mg/L | 2829** | 300 |
| 3. | Turbidity | Nephelometric turbidity unit (NTU) | 1.99 | 3 |
| 4. | Color | True colour unit (TCU) | tt <0.70 | 10 |
| 5. | Odor | - | Odorless | Odorless |
| **Tap water** | | | | |
| 1. | Temperature | °C | 26.0 | - |
| 2. | TDS | mg/L | 133 | 300 |
| 3. | Turbidity | NTU | 0.62 | 3 |
| 4. | Color | TCU | tt <0.70 | 10 |
| 5. | Odor | - | Odorless | Odorless |
| **Gallon water** | | | | |
| 1. | Temperature | °C | 26.1 | - |
| 2. | TDS | mg/L | 58 | 300 |
| 3. | Turbidity | NTU | 0.5 | 3 |
| 4. | Color | TCU | tt <0.70 | 10 |
| 5. | Odor | - | Odorless | Odorless |
| **RWH** | | | | |
| 1. | Temperature | °C | 26.0 | - |
| 2. | TDS | mg/L | 20 | 300 |
| 3 | Turbidity | NTU | 1.59 | 3 |
| 4. | Color | TCU | tt <0.70 | 10 |
| 5. | Odor | - | Odorless | Odorless |
| | | **Chemical criteria** | | |
| **Groundwater** | | | | |
| 1. | pH | - | 7.55 | 6.5–8.5 |
| 2. | Manganese | mg/L | 0.1926* | 0.1 |
| **Tap water** | | | | |
| 1. | pH | - | 7.78 | 6.5–8.5 |
| 2. | Manganese | mg/L | tt <0.0027 | 0.1 |
| **Gallon water** | | | | |
| 1. | pH | - | 7.71 | 6.5–8.5 |
| 2. | Manganese | mg/L | tt <0.01 | 0.1 |
| **RWH** | | | | |
| 1. | pH | - | 6.69 | 6.5–8.5 |
| 2. | Manganese | mg/L | tt <0.0027 | 0.1 |
| | | **Microbiological criteria** | | |
| **Groundwater** | | | | |
| 1. | Total coliforms | Colony/100 mL | > 1,000*** | 0 |
| 2. | E-coli | Colony/100 mL | > 1,000*** | 0 |
| **Tap water** | | | | |
| 1. | Total coliforms | Colony/100 mL | 1* | 0 |
| 2. | E-coli | Colony/100 mL | 0 | 0 |
| **Gallon water** | | | | |
| 1. | Total coliforms | Colony/100 mL | <1.8* | 0 |
| 2. | E-coli | Colony/100 mL | <1.8* | 0 |
| **RWH** | | | | |
| 1. | Total coliforms | Colony/100 mL | > 1,000*** | 0 |
| 2. | E-coli | Colony/100 mL | 34.5** | 0 |

*** parameters exceed quality standard, with the level represented by the number of symbol

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# Kualitas Air RWH

(Hasibuan *et al.*, 2024)

# Potensi Kuantitas RWH pada Mitigasi *Land Subsidennce*

**KEMAMPUAN MEMENUHI**

Penerapan instalasi RWH eksisting dapat memenuhi 0,2% sumber air bersih untuk kebutuhan sanitasi

Setiap instalasi RWH eksisting dapat memproduksi 20.010, 24 Liter/bulan (area tangkap: 80 m; Run-off koefisien: 0,9; intensitas curah hujan: 277,92 mm)

Untuk 2.053 KK dengan total kebutuhan 9.700,425 L dan kebutuhan per KK adalah 4.725 Liter

(Hasibuan *et al.*, 2024)

# Penggunaan Air Tanah & Mitigasi *Land Subsidence*

| Well depth (m) | Total | |
|---|---|---|
| | n | % |
| 0.15-1.00 | 18 | 33.96 |
| 1.01-3.00 | 26 | [illegible] |
| 3.01-5.00 | 7 | 13.21 |
| 5.01-10.00 | 3 | 3.77 |
| >10.00 | 0 | 0 |

Setiap KK menggunakan **174,6 Liter air tanah per hari.**

Peningkatan kapasitas **produksi RWH** hingga **70%-80%** mampu **mereduksi** pengunaan **air tanah secara signifikan**

(Hasibuan *et al.*, 2024)

# Rekomendasi Kebijakan Penerapan RWH untuk Mitigasi *Land Subsidence*

***EXPANDING* RWH**

***POLICY & REGULATION SUPPORT***

(Furumai, 2008)

***AWARENESS & EDUCATION SUPPORT***

***INCENTIVES & SUBSIDIES***

(Richards et al., 2021)

(Hasibuan *et al.*, 2024)


City and Environment Interactions

ELSEVIER

Policymaking and the spatial characteristics of land subsidence in North Jakarta

ARTICLE INFO

ABSTRACT

Introduction


Global Journal of Environmental Science and Management (GJESM)

Homepage: https://www.gjesm.net/

CASE STUDY

Potential application of rain water harvesting technology as an alternative clean water source to mitigate land subsidence

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ABSTRACT

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NUMBER OF FIGURES 4

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# SUMBER REFERENSI

**Publikasi Terindeks Internasional (PUTI) Q2 (Batch 1)**

**Penelitian Fundamental Reguler 2024 (Kemendikbudristek)**

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# PROJEK RWH




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ShortDoc: "The Rain collector", realised by Mr. Jeffri Kahu

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