Flood Hazard Maps: An Update

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JABATAN PENGAIRAN DAN SALIRAN MALAYSIA

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Introduction

INTRODUCTION

- Flooding is a natural phenomenon and has been occurring for millions of years
- Civilisations started at river valleys and tends to be the most populated thus attribute to the flooding incidences – losses of life and property
- Nowadays, flooding is aggravated by development where natural flood plains (wetlands) are backfilled
- To mitigate the floods engineers have become creative in producing ambitious engineering designs (SMART, 3 Gorges, Dam Thames Barrier)
- Highly advanced computer modelling and effective flood mapping now provide disaster authorities to predict with amazing accuracy where floods will occur and how severe they're likely to be

FLOODS IN MALAYSIA

- Major floods was recorded since 1926, followed by 1949 and 1971
- 9% (~30,000 sq km) of the total area of the country is prone to flooding
- ~ 4.8 million people live in areas prone to flooding
- Recent floods – 2006, 2007 and in January 2011, some urban areas in Johor - including Segamat, Johor Bahru, Kluang, Kota Tinggi, and Muar - were flooded and completely cut off.
- In this state alone, between 40,000 - 70,000 people were evacuated, and at least two people died in this particular occurrence.
- Both waves of these disasters were considered to be the costliest floods in Malaysia's history, with a total cost of RM1.5 billion.

CHALLENGES IN FLOOD MANAGEMENT

- Floodplains are being developed
- Residents / stakeholders have high expectations and less tolerance towards flooding
- Structural flood management costs is rising
- Non-structural approach has not been well accepted
- Global climate change

FLOOD EVENTS IN MALAYSIA

FLOOD EVENTS IN MALAYSIA

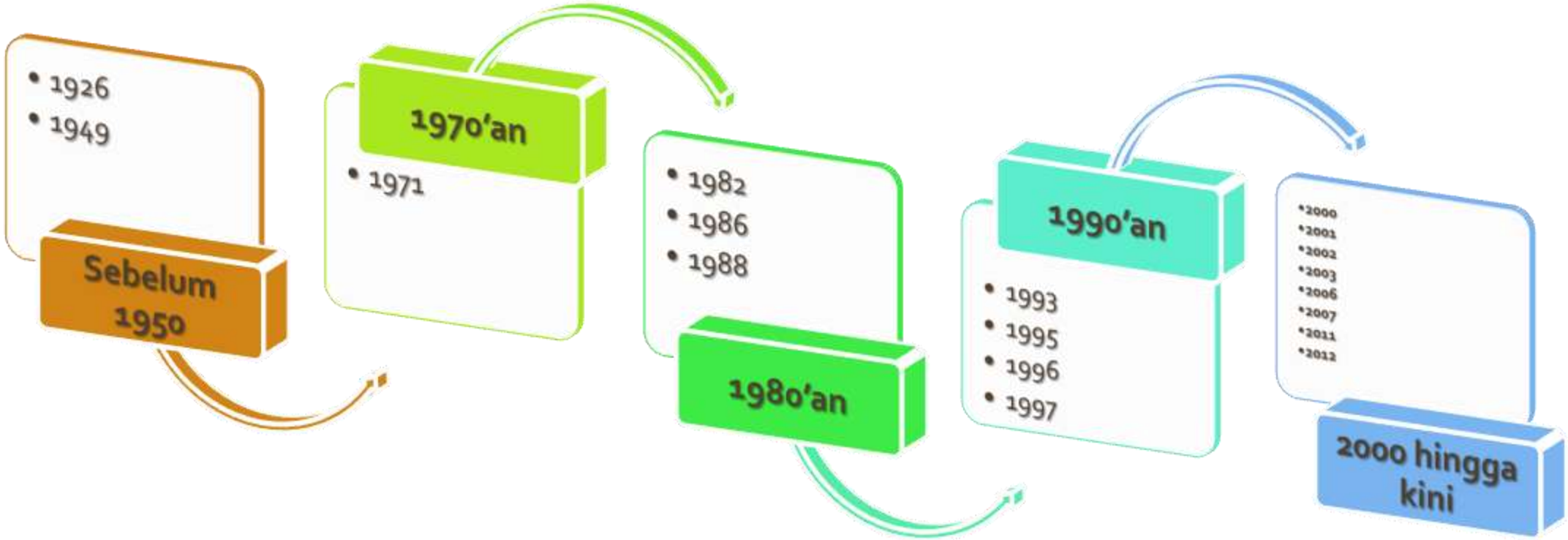
2007

2007

2011

2011

FLOOD EVENTS IN MALAYSIA – KLANG VALLEY



FLOOD EVENTS IN MALAYSIA

PARAS DADA...penduduk Sungai Serai menyelamatkan diri, semalam.

Banjir Kilat di Hulu Langat

Ratusan rumah ditenggelami air

DAYUNG...penduduk Sungai Serai diselamatkan.

KANDAS...sebuah kereta dinaiki air di Dusun Tua.

BEDAH ...pelajar mengharungi lah di Dusun Tua, semalam.

SANTU...operasi menyelamat di Sungai Serai.

Hulu Langat, Selangor – 13 March 2009

PENDUDUK Taman Bukit Beruang Utama, Melaka cuba menyelamatkan kereta yang tenggelam akibat banjir kilat semalam.

Melaka dilanda banjir kilat

MELAKA – Beberapa kawasan di negeri i berikutan hujan lebat sejak pukul 10

Melaka Tengah, Melaka - 27 July 2009

DUA anggota JPAM membawa keluar kanak-kanak untuk dihantar ke pusat pemindahan sementara selepas beberapa buah kampung dinaiki air dalam kejadian banjir kilat awal pagi semalam di Kampung Paya Redan, Muar.

120 penduduk lima kampung dipindah

Paras air naik mendadak hing

Muar, Johor – 25 June 2010

FLOOD EVENTS IN MALAYSIA

Three states hit, some schools delay start

FLOOD ROUND-UP

KUANTAN: Conditions in Pahang continued to deteriorate yesterday as the steady downpour since Thursday raised water levels in rivers. A total of 246 people in Pekan and here have been evacuated.

Ten picnickers were stranded at the Berkelah waterfalls near Gambang as the heavy rain has raised the level of Sungai Berkelah, cutting off the only exit route.

As of 7pm, a Civil Defence Force team had yet to rescue them.

The lower areas of Sungai Lembing town are under two metres of water after Sungai Kuantan burst its banks at Bukit Kenau.

Rows of shophouses were shuttered as residents of the former tin mining town sought shelter on higher ground.

A state flood operations room spokesman said yesterday as of 6.30pm, 124 people in Sungai Jeliang and several parts of Sungai Lembing were evacuated to the district police station while another 14 were sheltering 56 people from Kampung Rompin Lama, Kampung Penadah and Kampung Padang Polo.

Another 19 from Kampung Padang Rumbia were sheltering in the community hall, while 18 people from Chenor and Km14 of the Pekan-Nenasi road are closed to all traffic except heavy vehicles.

The coastal road from Pantai Sepat to Pekan and Jalan Kuantan-Maran was also closed to light traffic. Jalan Pekan-Rompin was closed to level, while Sungai Galas at Dabong, Sungai Lebir (Tualang) and Sungai Kelantan (Kuala Krai, Kusial, Customs jetty) have reached alert levels.

The Pasir Puteh-Kota Baru road was closed to light vehicles yesterday as a stretch at cipals to shut down and place the school day on Sa day, if the water level con ues to rise.

"We feel it is better to c rather than inconvenie parents when they reg their children for the first

The Sungai-Lembing Kuantan road is closed to light traffic, but this car is still attempting to get through.

Shophouses with shutters down in Sungai Lembing while owners sought shelter on higher ground.

Kuantan, Pahang - 2 January 2009

Lebih 8,000 mangsa di Terengganu, Kelantan dipindahkan

Banjir makin buruk

- Di **Terengganu** 5,641 mangsa daripada 1,288 keluarga dipindahkan ke pusat pemindahan banjir.
- 300 calon Sijil Pelajaran Malaysia (SPM) dan Sijil Tinggi Persekolahan Malaysia (STPM) 'berkampung' di tujuh sekolah menengah di Besut bagi pastikan mereka dapat duduki peperiksaan hari ini.
- Jalan Sungai Tong-Kuala Berang ditutup kerana dinaiki air setinggi 1.2 meter, Jalan Penarik-Permaisuri (0.5 meter), Jalan Ajil - Kuala Berang (0.9 meter).
- Di **Kelantan** 2,668 mangsa daripada 480 keluarga dipindahkan ke 729 pusat pemindahan.
- Paras air Sungai Kelantan di Kusial, Kuala Krai, Sungai Golok dan Rantau Panjang melebihi paras bahaya.

"Penggemar keropok lekor tidak perlu bimbang untuk menikmati makanan itu asalkan membelinya dari gerai yang bersih

- DR. NORDIYANAH HASSAN
Pengarah Jabatan Kesihatan Negeri Terengganu

PINDAH CALON SPM

GELOMBANG kedua banjir yang melanda Pantai Timur Semenanjung menyebabkan beribu penduduk terpaksa dipindahkan ke tempat yang selamat.

Berikutan bencana alam itu, pelajar-pelajar yang sedang menduduki peperiksaan SPM dan STPM turut dipindahkan.

Sementara itu, beberapa jalan ditutup manakala KTM Berhad menangguhkan empat perkhidmatan di sektor Pantai Timur semalam.

[Lagi berita, gambar di muka 14, 15]

● LIMA calon SPM dari Sekolah Menengah Agama Mahmudiah menaiki sampan untuk dipindahkan setelah bangunan asrama mereka dinaiki air di Kuala Berang, Hulu Terengganu semalam. - UTUSAN/ACZI RAHARUDIN

Kelantan & Terengganu - 20 November 2009

FLOOD EVENTS IN MALAYSIA

Stranded

Wat-er mess: Cars parked behind the PWTC in Kuala Lumpur submerged in muddy flo waters after a downpour yesterday evening. — AHMAD ASMADI

Thousands caught unawares as 2m-high flash floods hit KL

Kuala Lumpur- 3 March 2010

Mangsa meningkat daripada 2,794 kepada 3,353 orang

Banjir di Sabah makin buruk

Kota Kinabalu, Sabah - 15 January 2010

aupun daerah Engkilili, Kapit, Song dilaporkan semakin pulih

anjir di Sibu tidak berubah

GAMBAR dari udara menunjukkan kawasan perkampungan Rumah Panjang dilanggani air ekoran hujan lebat dan air pasang besar di Sibu, Sarawak, semalam.

Sibu, Sarawak – 22 August 2010

The Development of Flood Map in Malaysia

FLOOD MAP DEVELOPMENT IN MALAYSIA

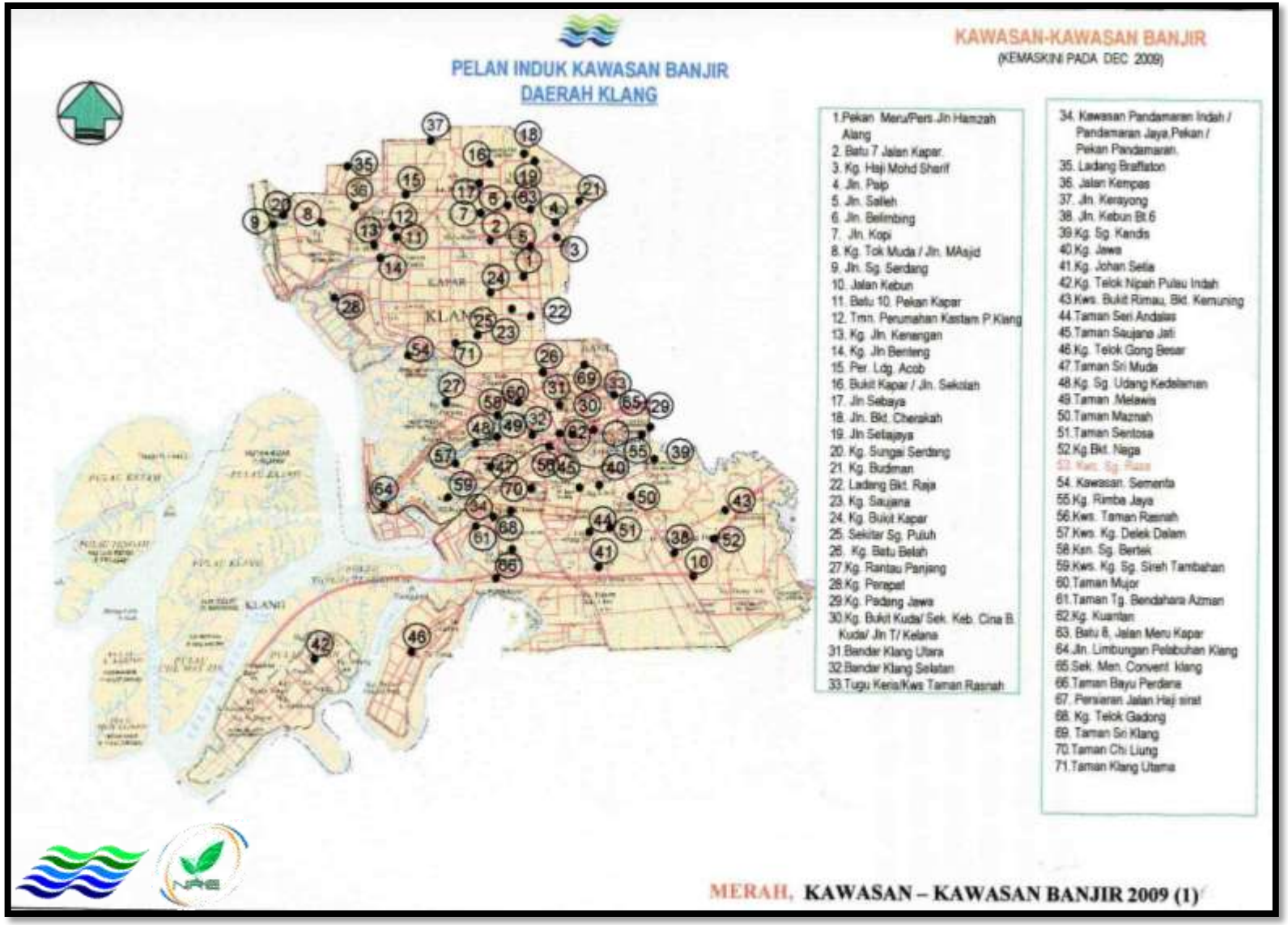
Flooded locations were only listed in flood reports

Flooded areas were marked on the map as a spot and does not signify acreage

Flooded area are drawn on a map based on the flooding that has occurred through field observations, satellite images (Inundation map) (historical)

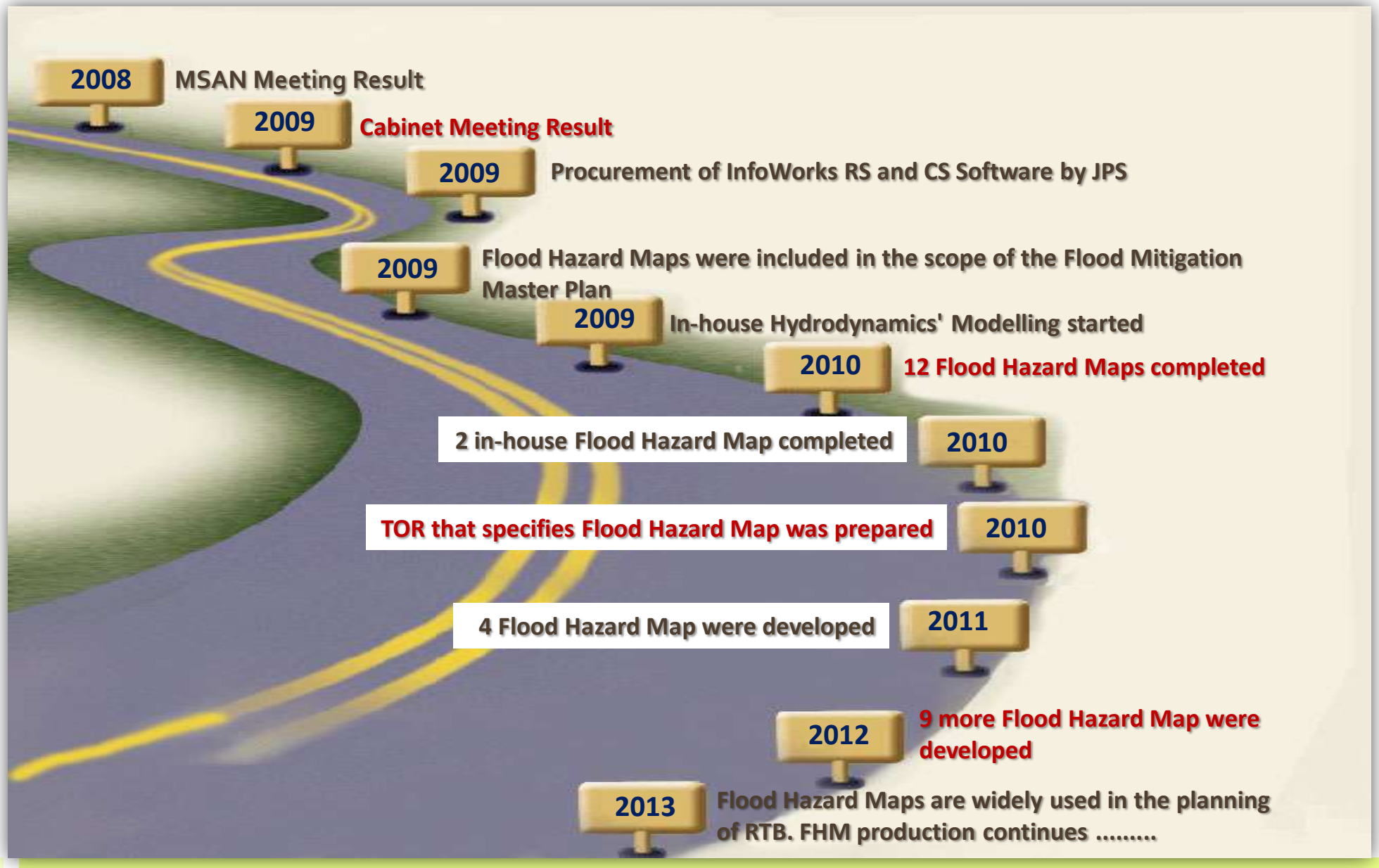
The flood extend are generated by a combination of river basin model and hydrology input using hydrodynamic modelling (Flood Hazard Map) (historical and prediction)

FLOOD MAP LOCATION



FLOOD MAP LOCATION

FLOOD MAP DEVELOPMENT IN MALAYSIA



INTEGRATED FLOOD MANAGEMENT

- Structural Measures
- Land-use Planning Measures
- Flood Preparedness Measures
- Flood Emergency Measures

STRUCTURAL AND NON-STRUCTURAL MEASURES

Environmental Sustainability

Structure

- Flood Mitigation Project
  - ✓ Upgrading the river and drainage systems
  - ✓ Dam
  - ✓ Reservoir
  - ✓ Diversion of river
  - ✓ Embankment of the river and the beach
  - ✓ Pump house

Non - Structure

-Floodplain Management
-Flood Forecasting & Warning
-Flood Map
-Land Use Planning
-Education & Awareness Population
-Development Control, MSMA (MSMA)

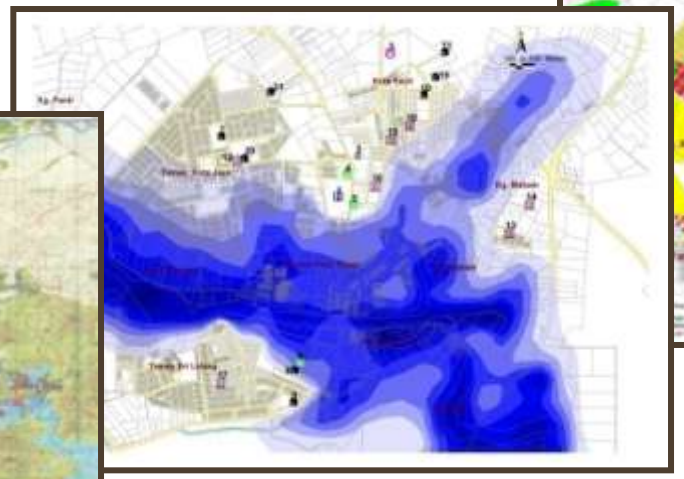
Aim to:
- Control and reduce flooding
- Reduce damage and flood losses
- Protect life and people's property

Flood Map

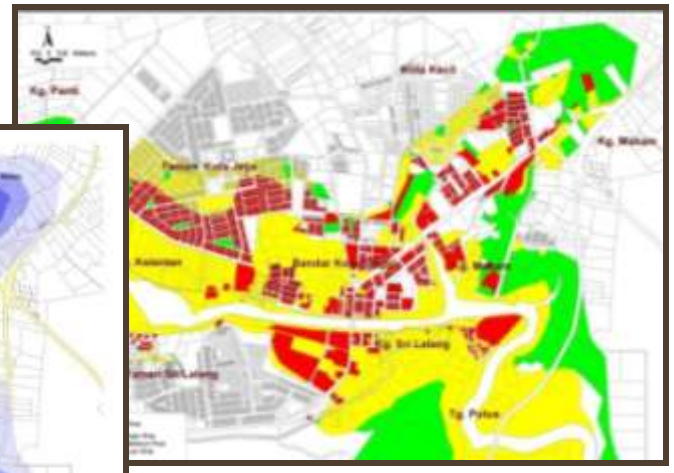
FLOOD MAP

- Three (3) types of Flood Map.
  i. *Flood Inundation Map*
  ii. *Flood Hazard Map*
  iii. *Flood Risk Map*

Flood Inundation



Flood Hazard Map

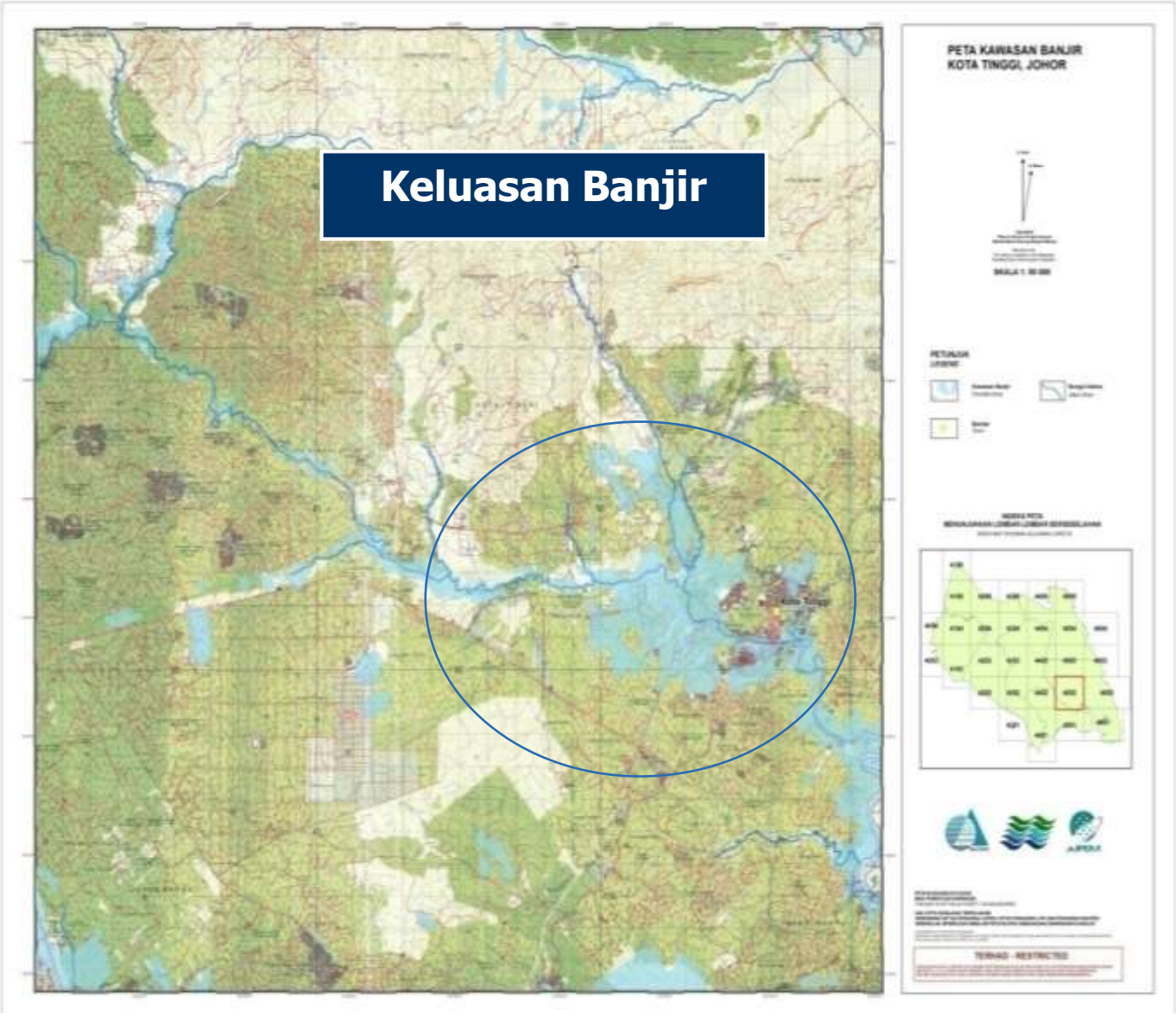


Flood Risk Map

FLOOD MAP USAGE

- Planning of flood mitigation projects
- Land use planning by the Local Authority (LA) and the Department Town and Country Planning (JPBD)
- Planning and placement of public facilities such as hospitals, schools, police stations, roads, and evacuation centers.
- Information and awareness of flood risk to residents and stakeholders
- The basis for the preparation of Flood Evacuation Map
- The basis for the preparation of Flood Risk Map

FLOOD INUNDATION MAP



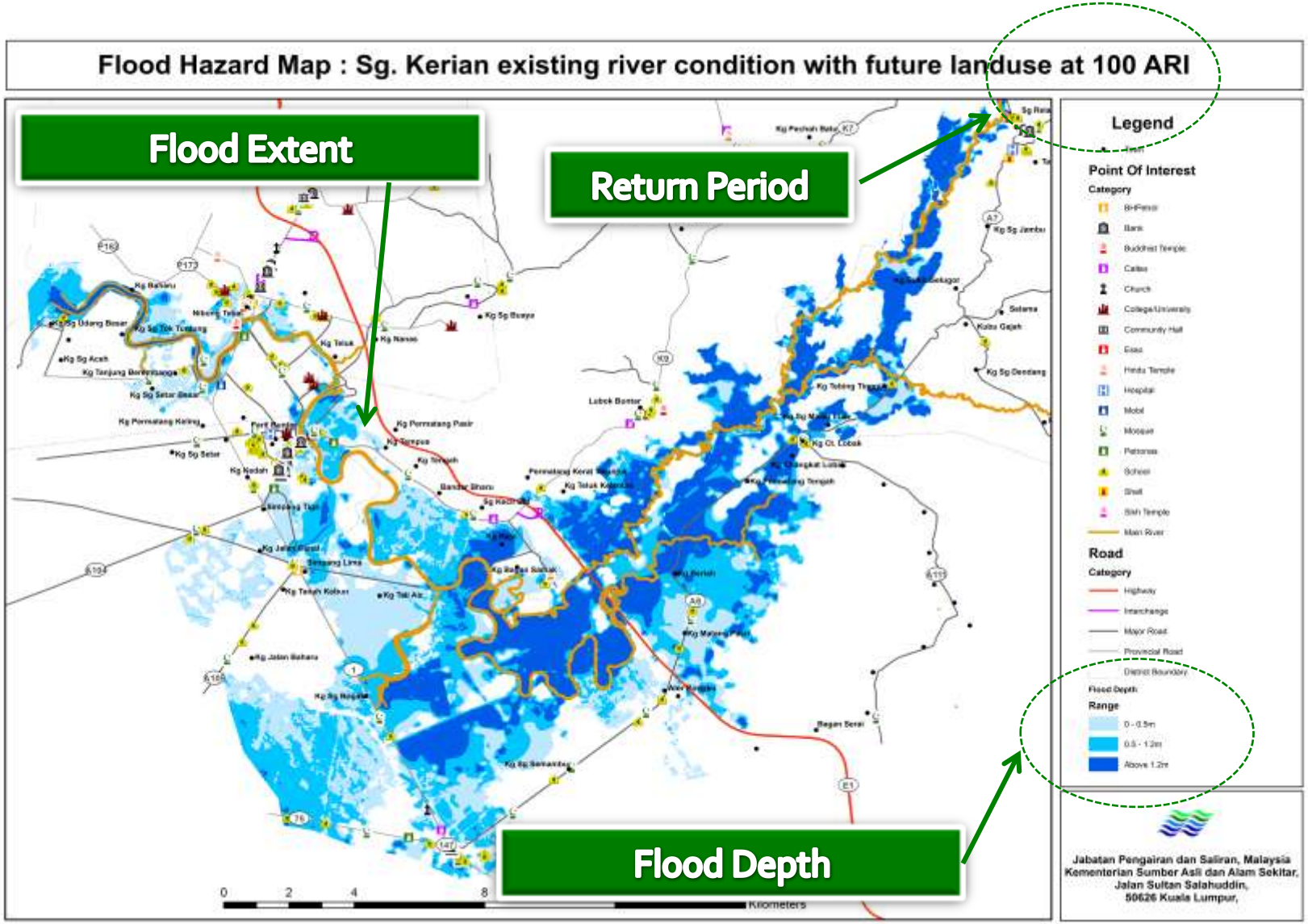
a. Process :

- ✓ Drawn based on the floods which have occurred
- ✓ Ground observations
- ✓ Satellite images

b. Output :

- ✓ Area and Capacity flood.

FLOOD HAZARD MAP



a. Process :

- ✓ Generated through a hydrodynamic modelling using the river basin model with hydrological input

Output :

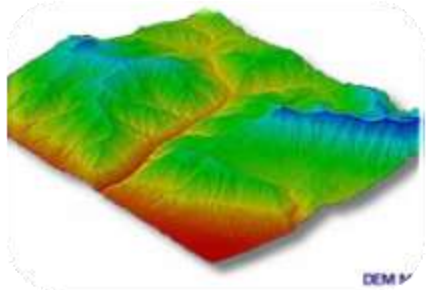
- ✓ Flood area
- ✓ Flood depth
- ✓ Flood velocity
- ✓ Flood extent

DATA REQUIREMENTS FOR FLOOD HAZARD MAP DEVELOPMENT

CATCHMENT AREA

RIVER ALLIGNMENT

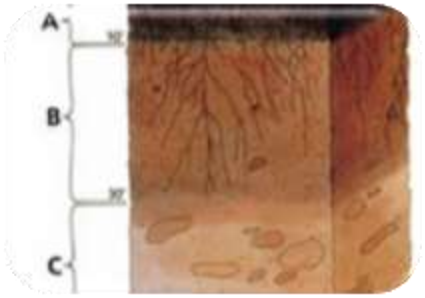
RIVER CROSS SECTION



3D MODEL GROUND SURFACE

STRUCTURE

LAND USE

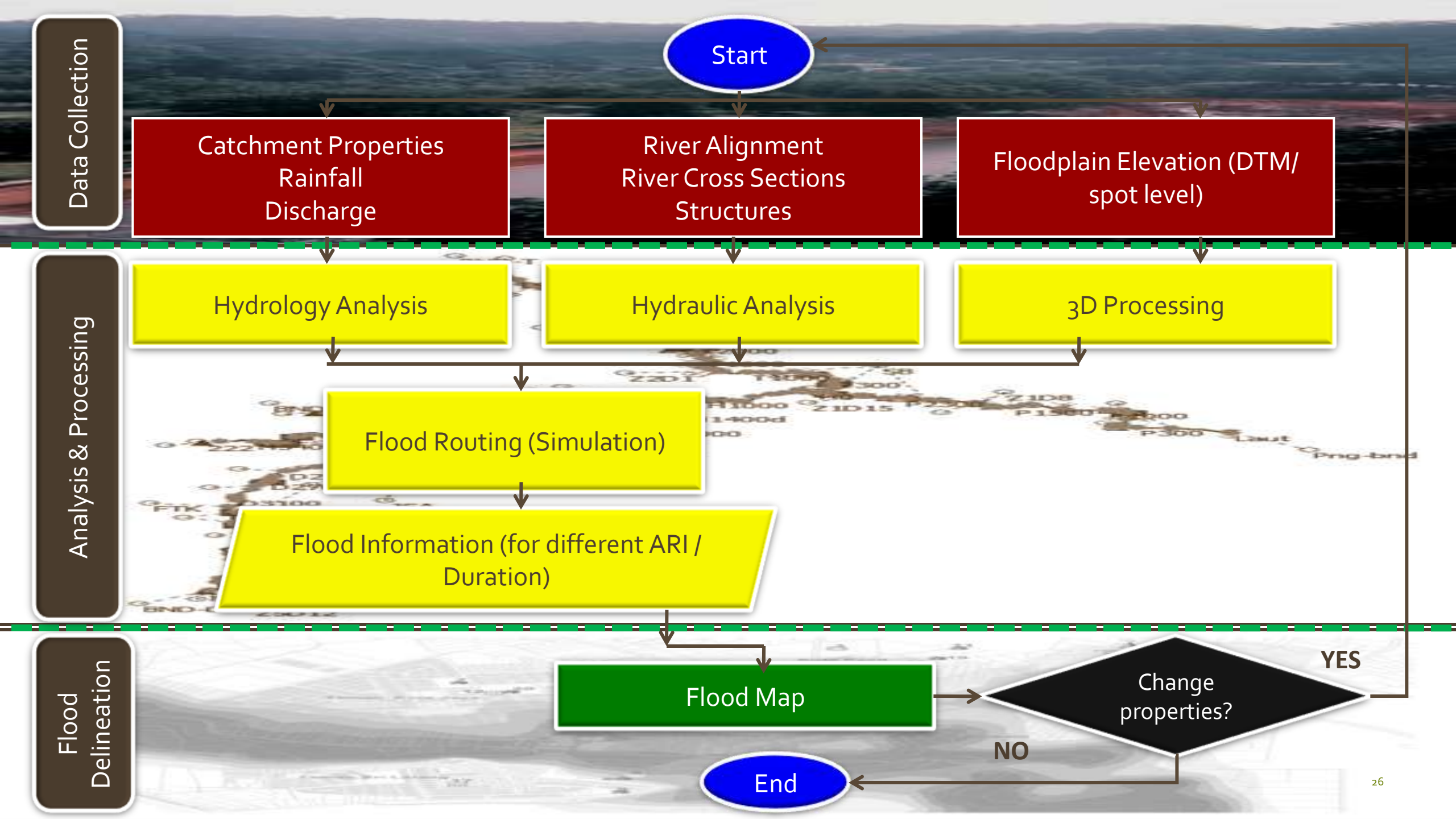


SOIL

RAIN

ROAD AND CADASTRAL

TIDAL

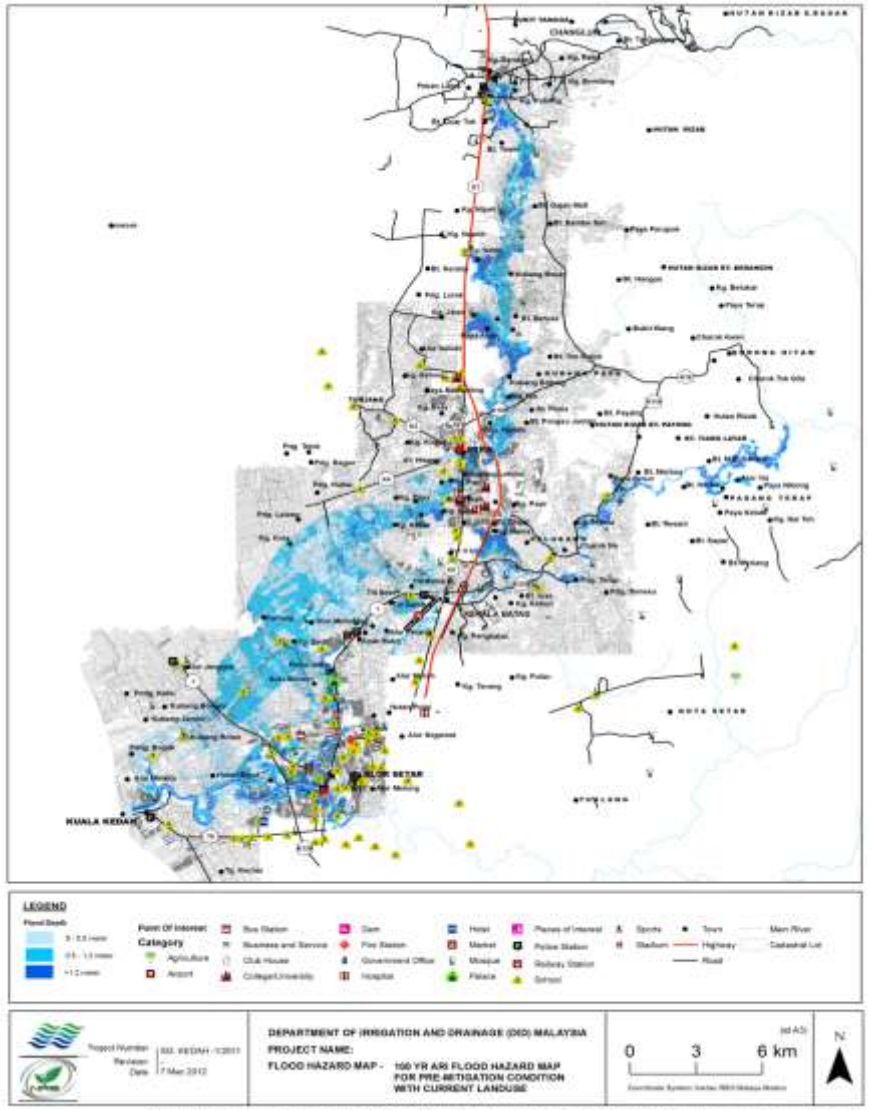

Data Collection
Start
Catchment Properties
Rainfall
Discharge
River Alignment
River Cross Sections
Structures
Floodplain Elevation (DTM/ spot level)
Analysis & Processing
Hydrology Analysis
Hydraulic Analysis
3D Processing
Flood Routing (Simulation)
Flood Information (for different ARI / Duration)
Flood Delineation
Flood Map
Change properties?
YES
NO
End

LIST OF COMPLETED FLOOD HAZARD MAP

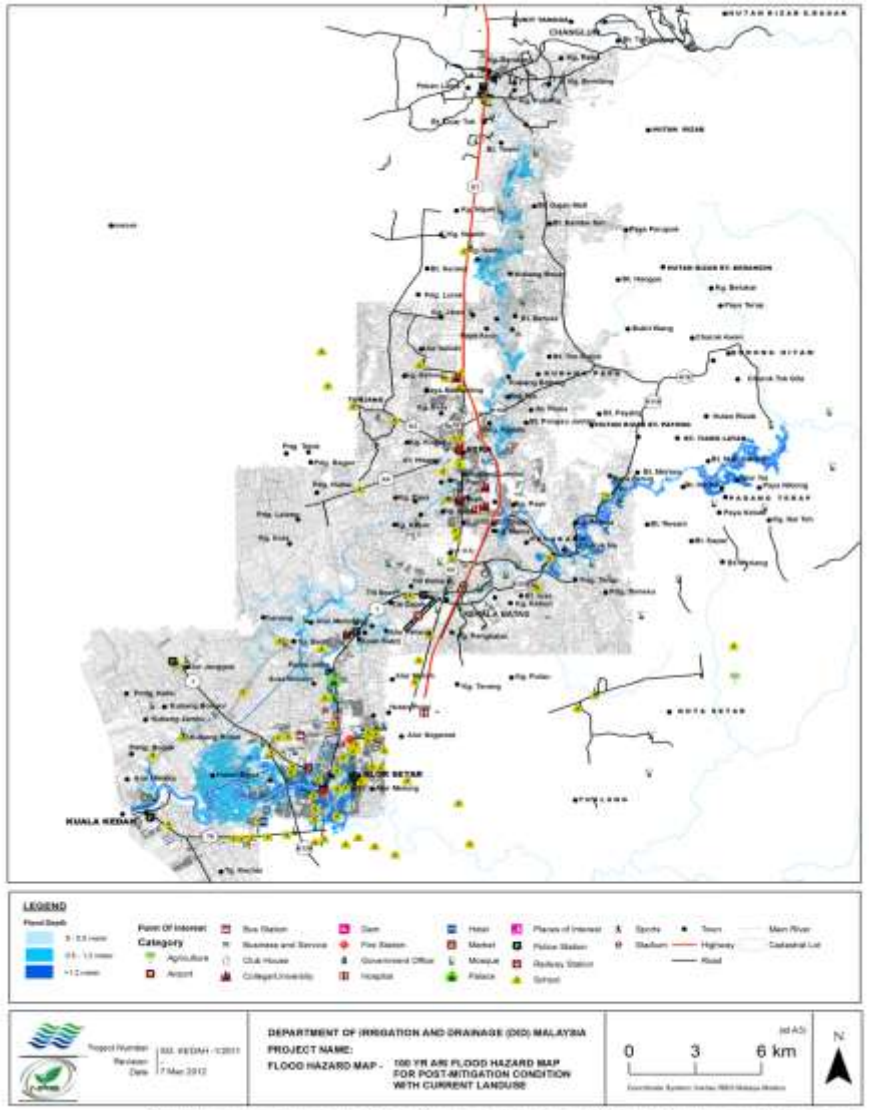
2010	2011	2012	2013
JOHOR 1. Kluang 2. Simpang Renggam 3. Batu Pahat 4. Muar 5. Mersing 6. Sg Johor SELANGOR 1. Sg Buloh 2. Sg Damansara 3. Sg Kuyoh PULAU PINANG 1. Sg Pinang KELANTAN 1. Pasir Mas 2. Tanah Merah	SABAH 1. Beaufort 2. Tenom 3. Sook KEDAH 1. Lembangan Sg Muda	MELAKA 1. Lembangan Sg Melaka 2. Lembangan Sg Kesang SELANGOR 1. Lembangan Sg Selangor 2. Lembangan Sg Labu, Sepang PERAK 1. Lembangan Sg Kerian 2. Lembangan Sg Kinta KEDAH 1. Lembangan Sg Kedah 2. Lembangan Sg Pendang PERLIS 1. Lembangan Sg Perlis & Sg Arau NEGERI SEMBILAN 1. Lembangan Sg Linggi JOHOR WPI – Skudai WPI – Sg Plentong WPI – Sg Melayu TERENGGANU 1. Lembangan Sg Setiu	PAHANG 1. Lembangan Sungai Pahang

SUNGAI KEDAH

100 year ARI – existing condition with current land use

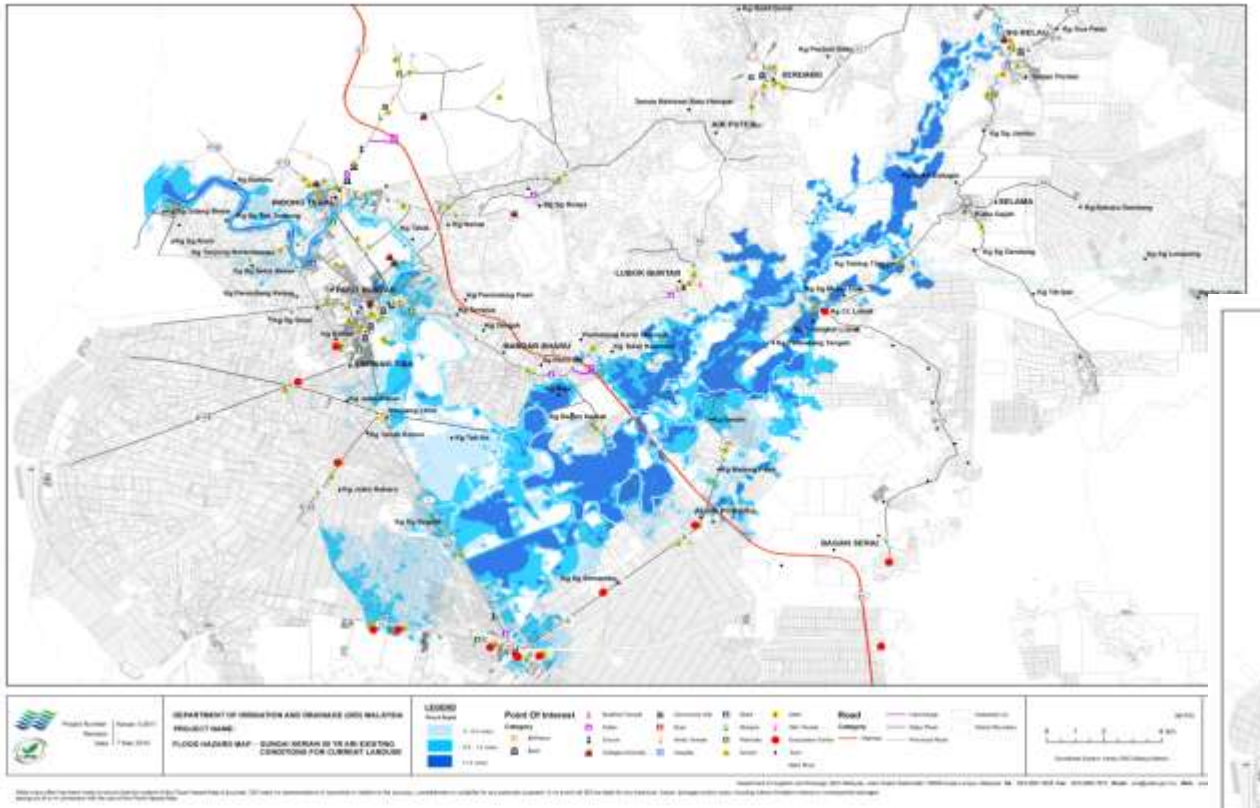


100 year ARI – mitigation condition with current land use

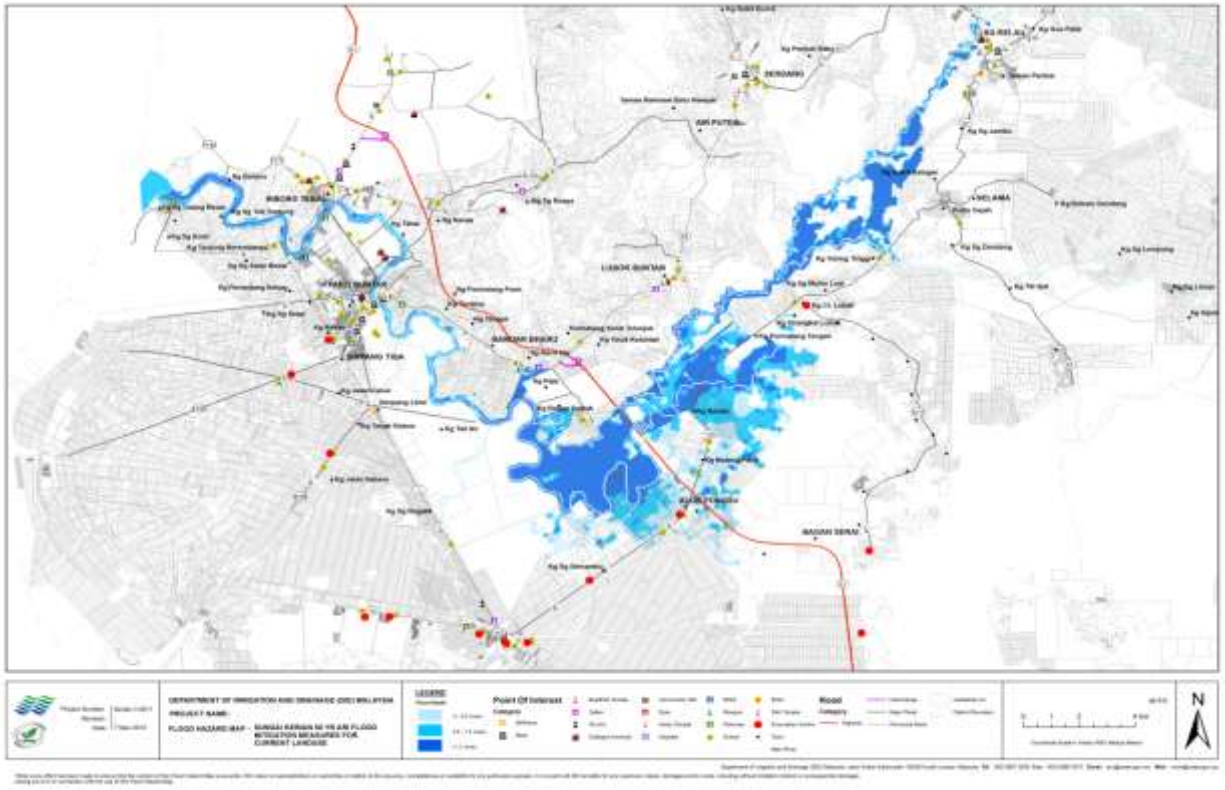


SUNGAI KERIAN

50 year ARI – existing condition
with current land use

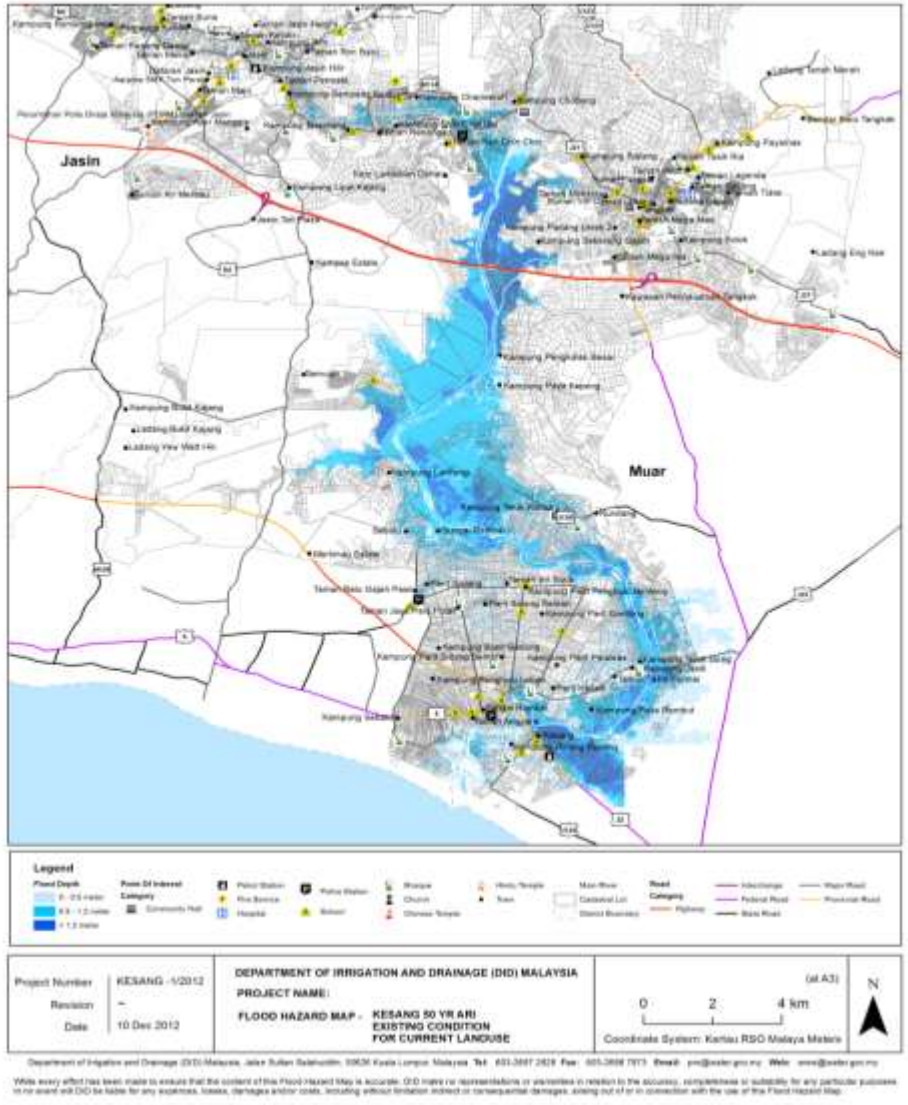


50 year ARI – mitigation condition
with current land use

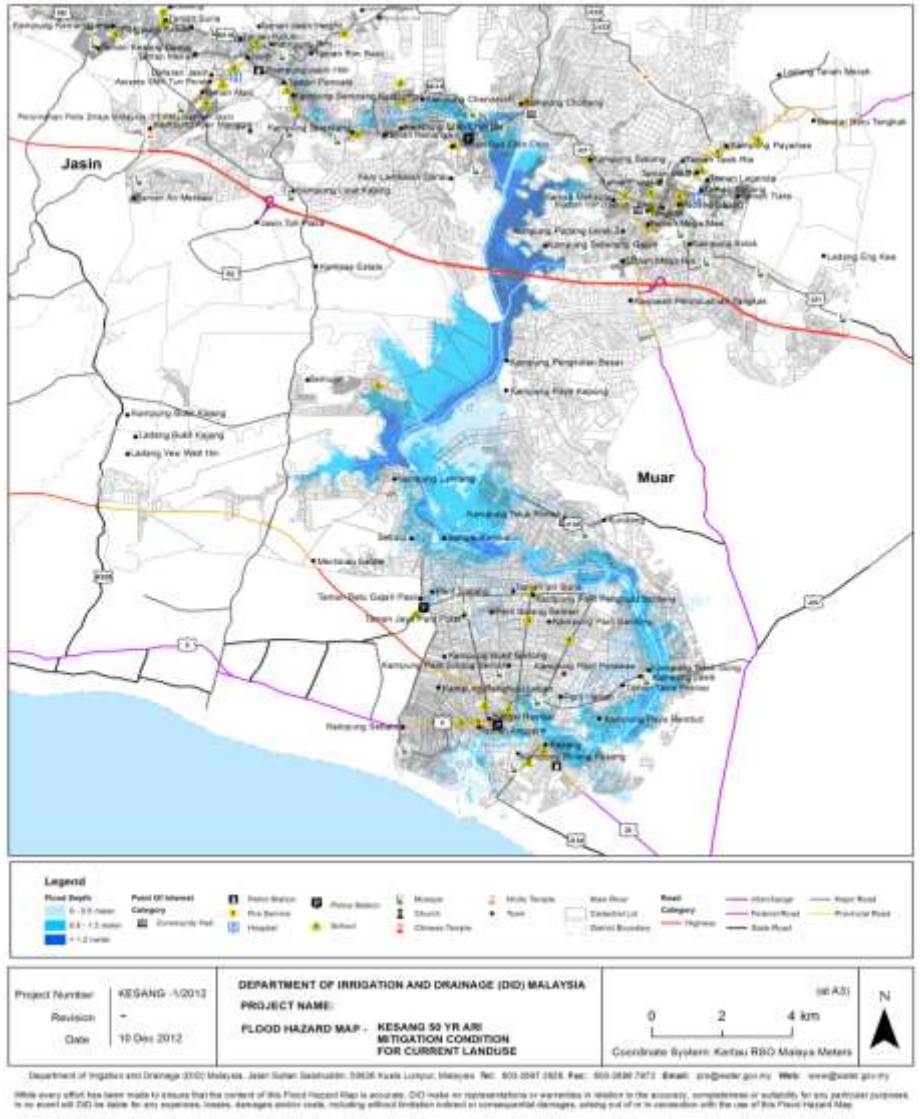


SUNGAI KESANG

50 year ARI – existing condition
with current land use

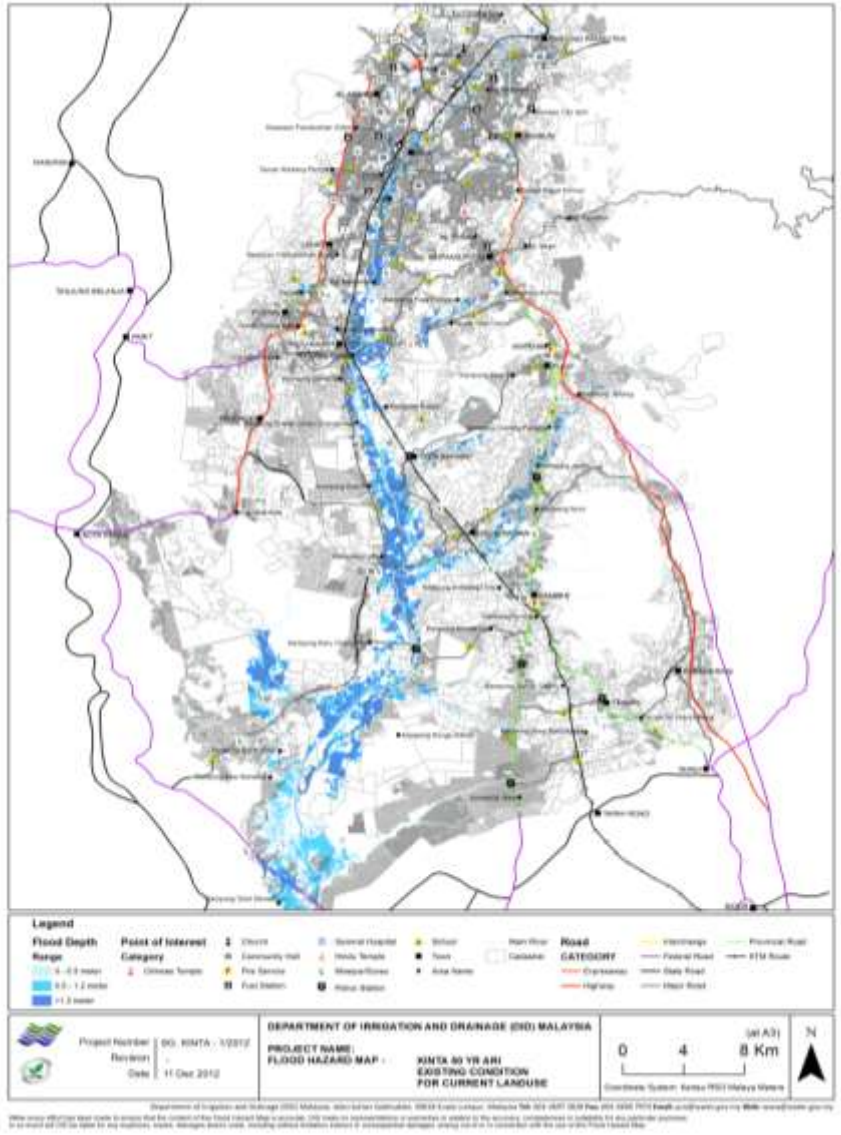


50 year ARI – mitigation condition
with current land use

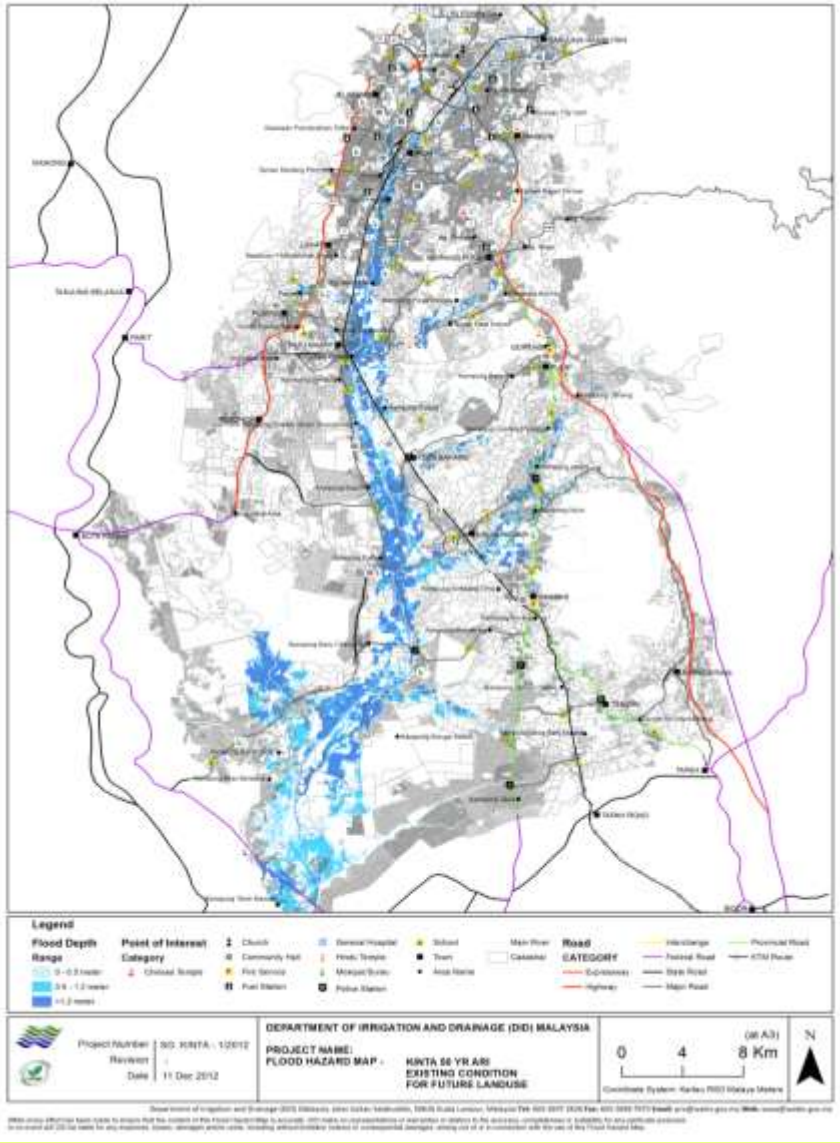


SUNGAI KINTA

50 year ARI – existing condition with current land use



50 year ARI – existing condition with future land use



Flood Risk Map – A Way Forward

"Flood risk is the combination of the probability of a flood event and the potential adverse consequences to human health, the environment and economic activities associated with a flood event."

Reference: European Flood Directive

FLOOD RISK MAP

- When all flood hazard's information becomes available it is possible to develop contours which indicate the severity of risk.
- A flood risk map has several direct economic effects, since it causes revision of all planning maps of the area.
- On the positive side, the map initiates the construction of flood loss prevention structures, alerts prospective land and property owners, as well as provides new developing ideas to the local planning authorities.
- Flood risk is the combination of the probability of a flood event and the potential adverse consequences to human health, the environment and economic activities associated with it.

RISK EQUATION

Risk can be assessed using this equation:

$$R = p_{si} \,.\, A_{Oj} \,.\, p_{Oj,si} \,.\, v_{Oj,Si}$$

where,

R = risk

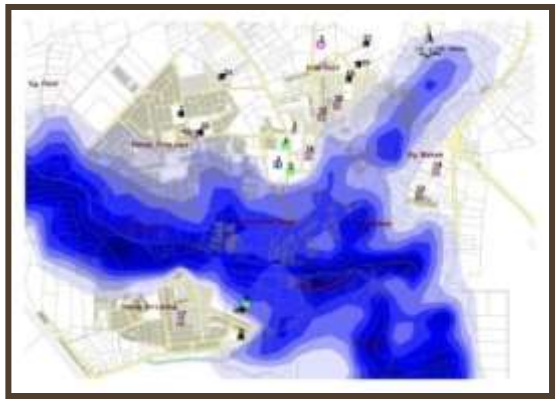
p_{si} = probability of scenario i

A_{Oj} = value at risk of object j

$p_{Oj,si}$ = probability of exposure of object j to scenario i

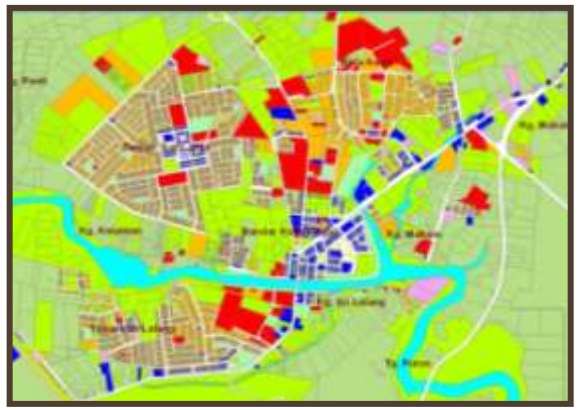
$v_{Oj,Si}$ = vulnerability of object j, dependent on scenario i

FLOOD RISK MAP



Flood Hazard Map

+

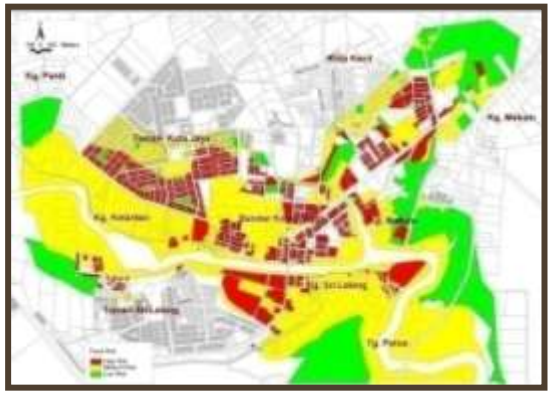


Vulnerability / Indices Map

1) Socio-economic
- Population
- Economy activity and asset

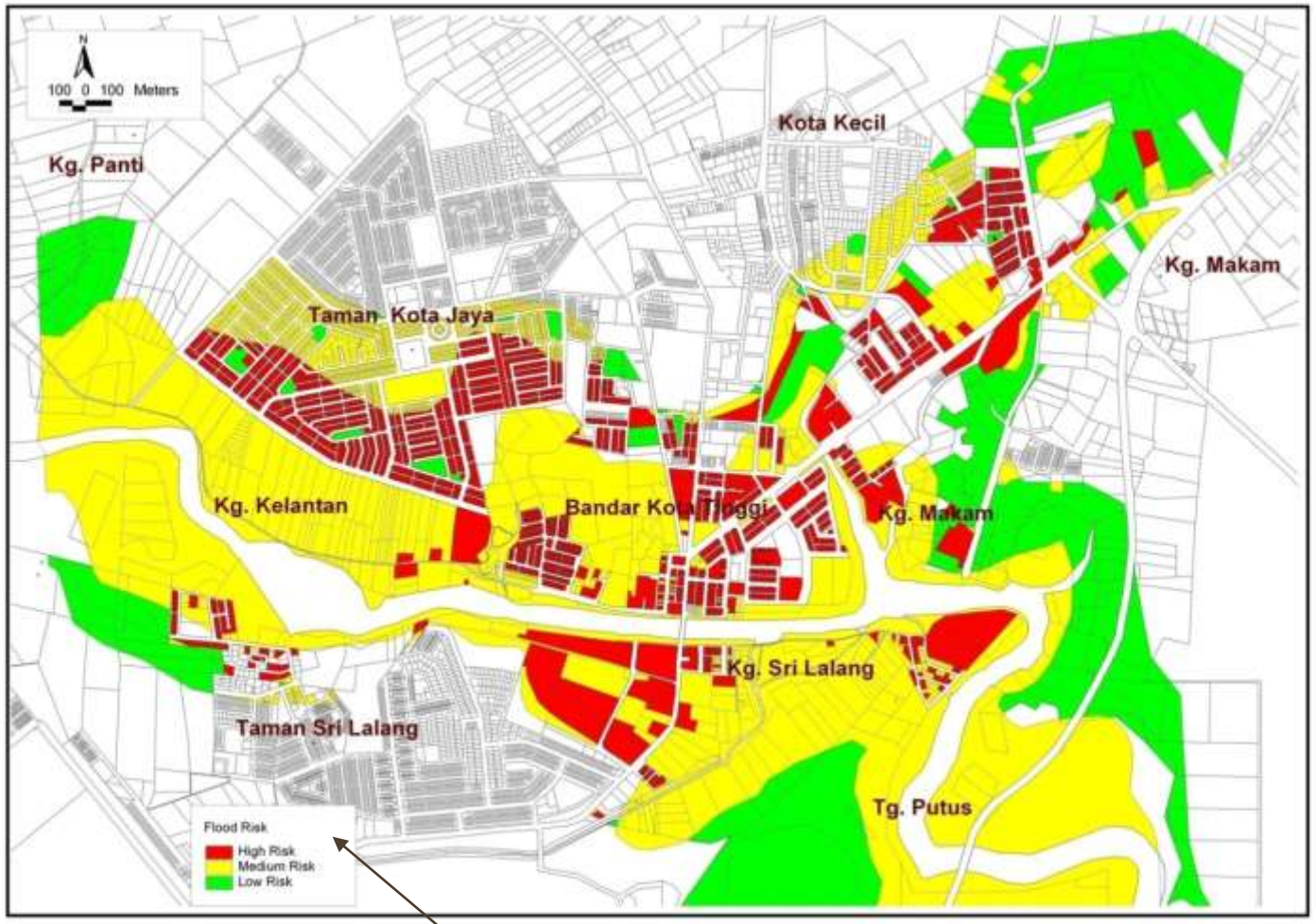
2) Enviromental issues
- Agricultural area
- Industrial and urban area
- Residential area

=



Flood Risk Map

FLOOD RISK MAP



Flood Risk Level Zoning

a. Process

- ✓ generated using hydrodynamic modelling methods

b. The combination of Hazard Map

- ✓ Flood map and Vulnerability/ Indices Map

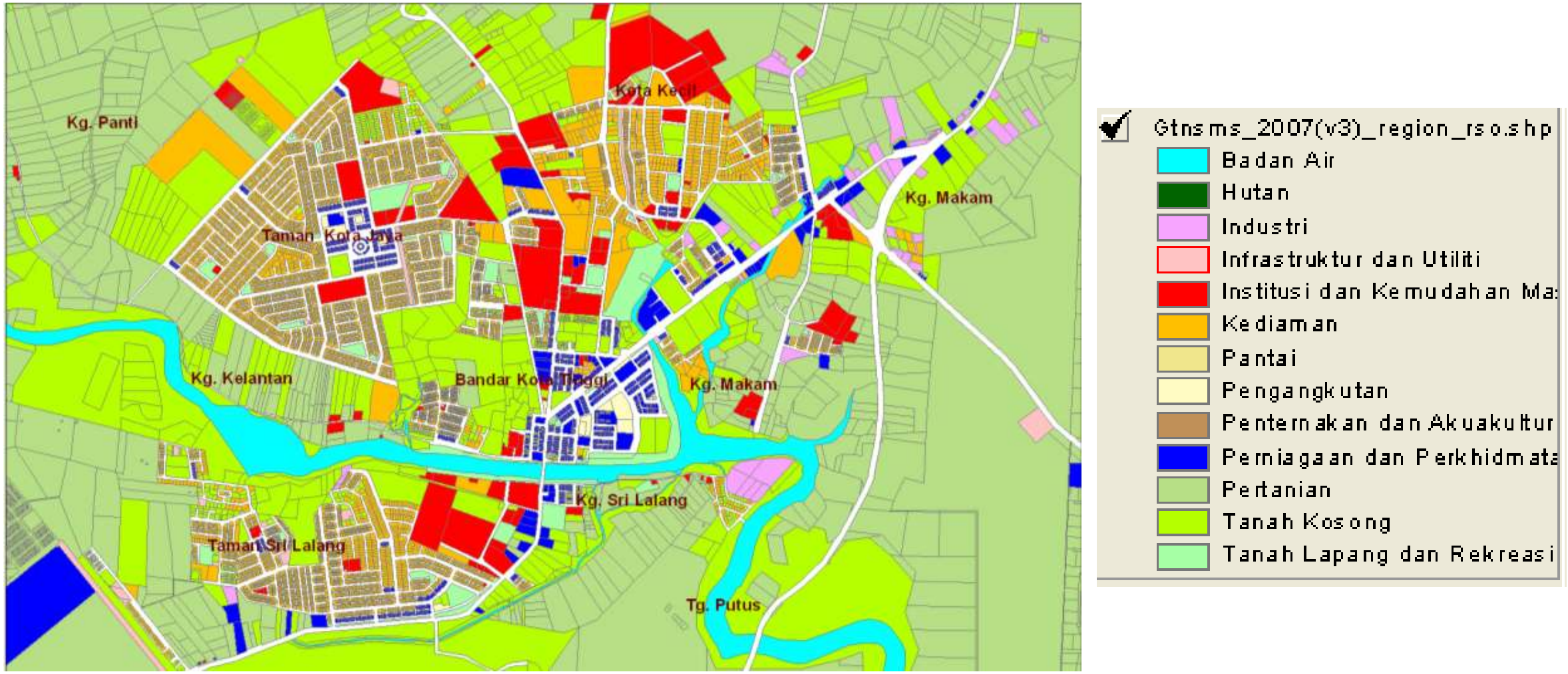
c. Output

- ✓ Assets zones at Risk

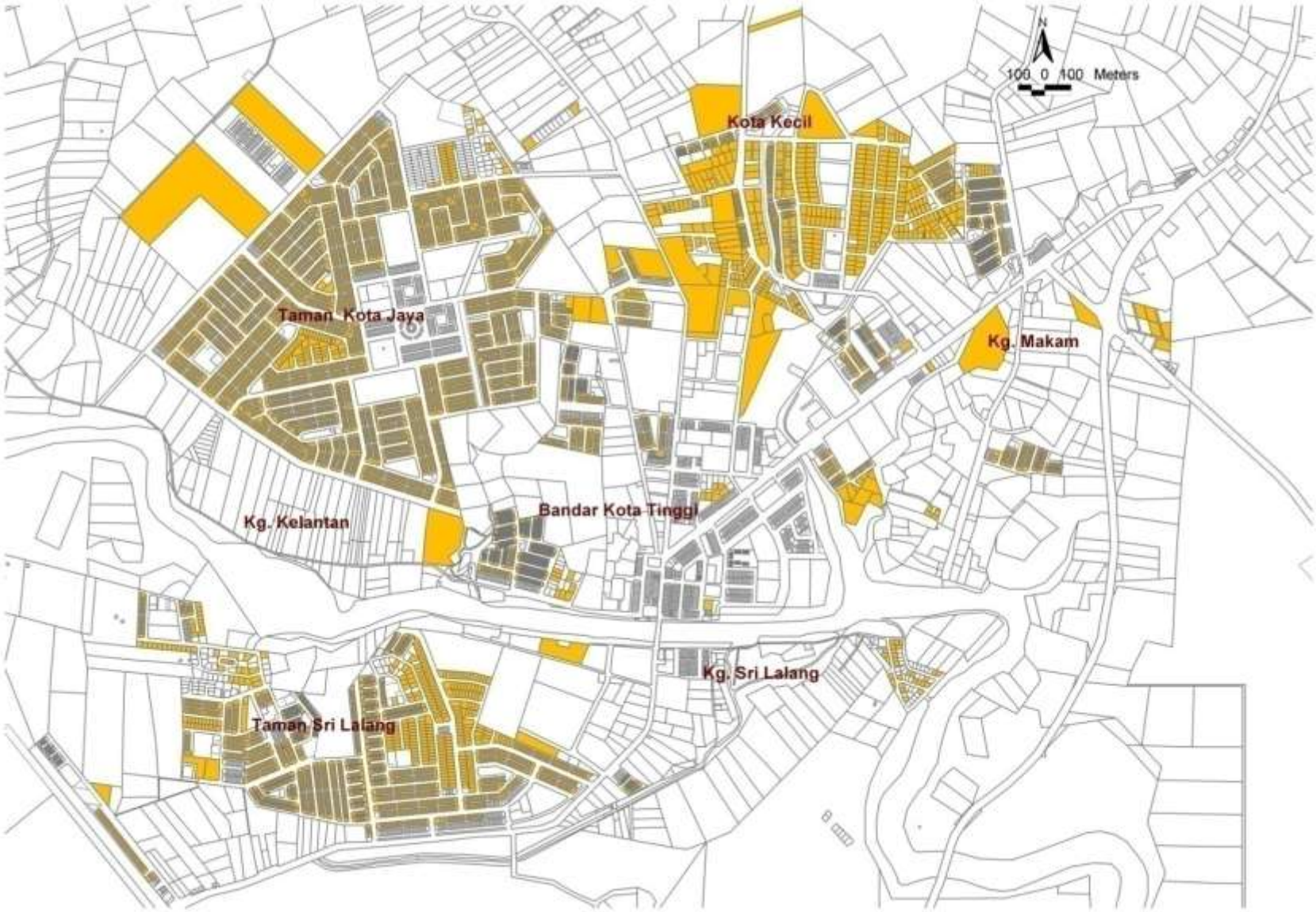
FLOOD RISK MAP

- As the way forward, the objective of flood-risk mapping is to assist local citizens and governments to develop effective methods of reducing flood-related damages in the community over the long run.
- It is clear that the least costly and most effective solution is to adopt a preventive approach which emphasizes longer range planning in flood-prone areas.
- Measures such as zoning by-laws, building codes and subdivision regulations can be used to control and direct land use within the flood hazard areas.
- Flood risk maps, together with supportive material and more detailed technical maps, will be prepared by DID to facilitate the preventive approach.

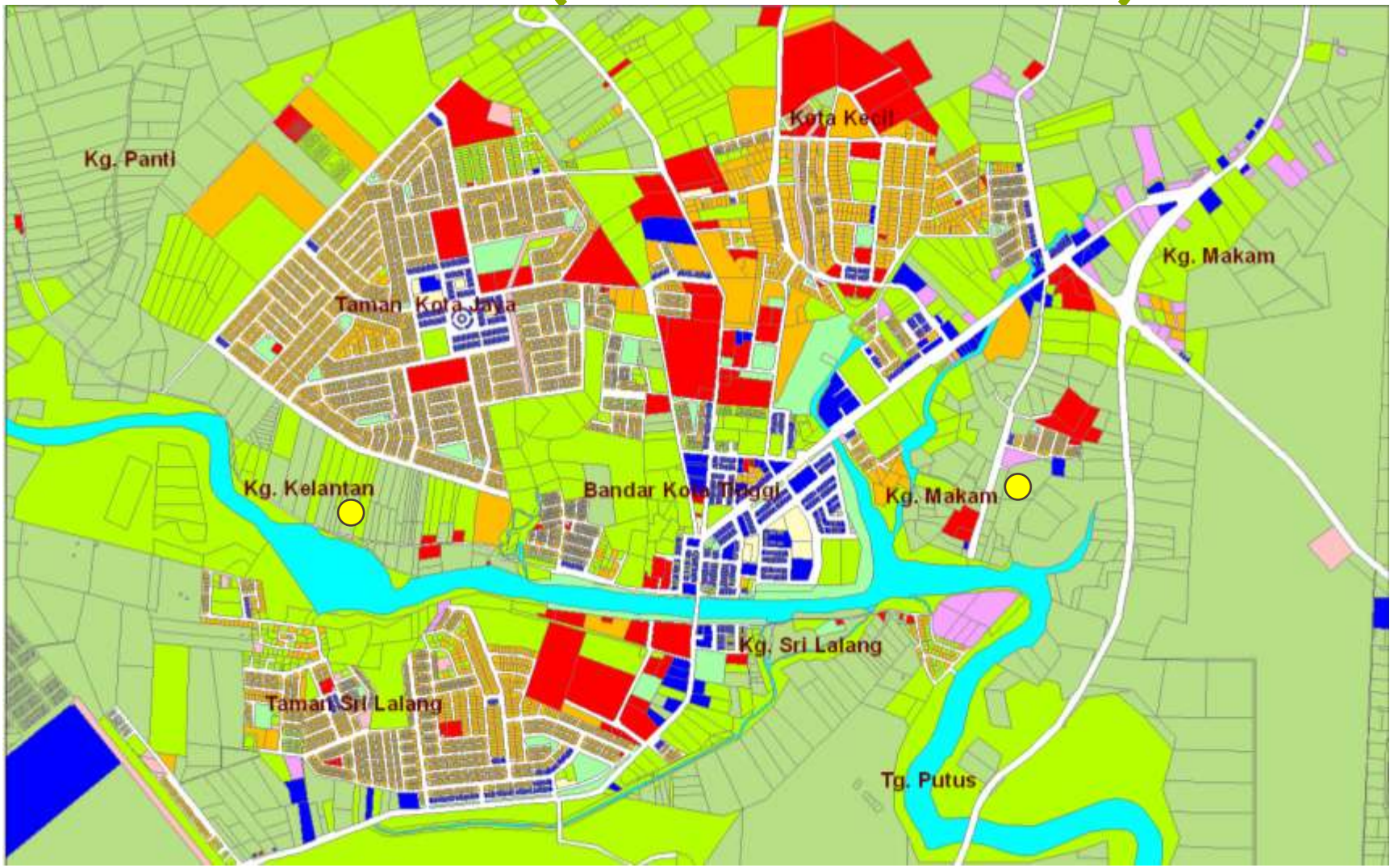
LAND USE (KOTA TINGGI)



POPULATION (KOTA TINGGI)

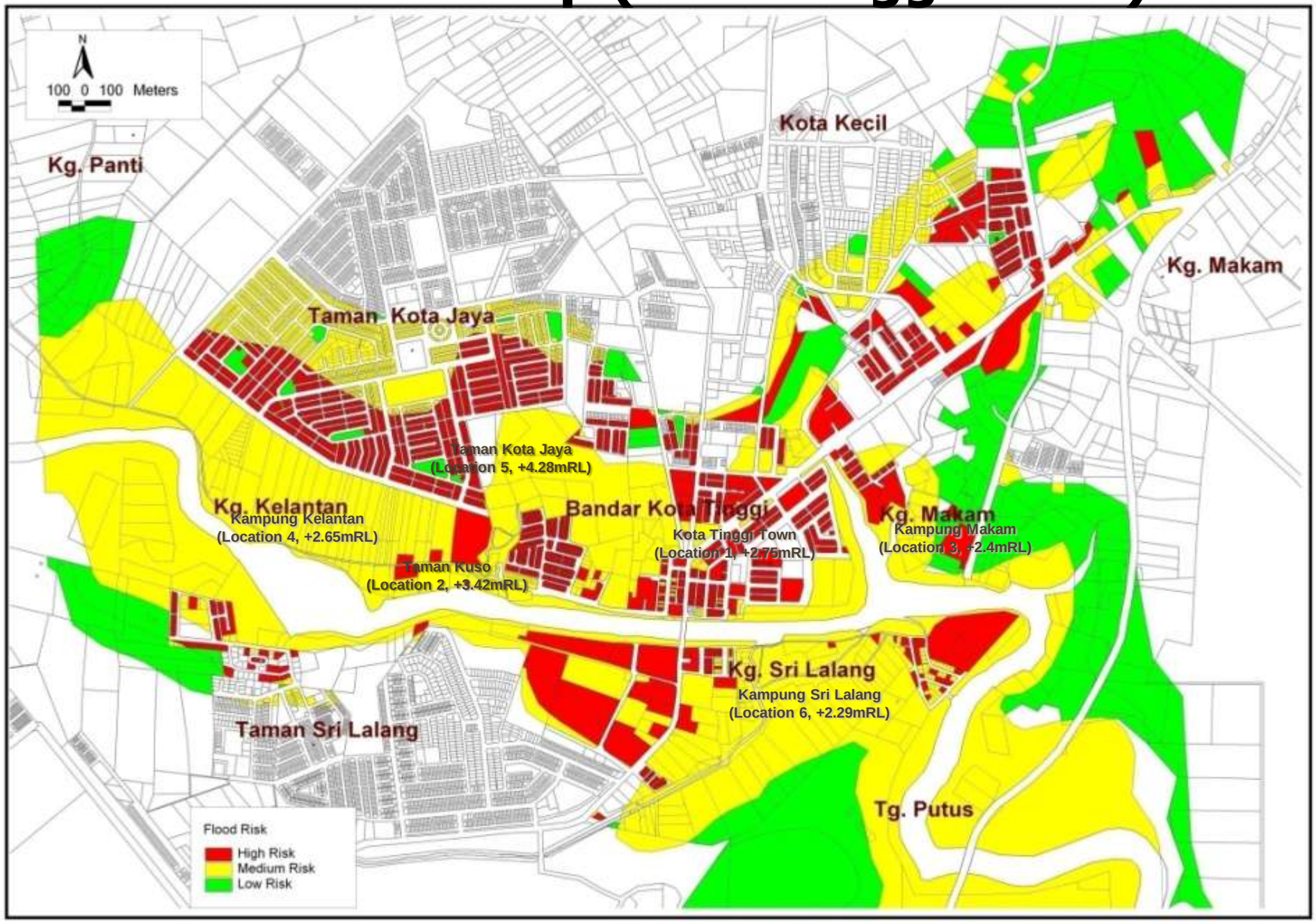


ENVIRONMENTAL SENSITIVE AREA (KOTA TINGGI)



Historical area

Flood Risk Map (Kota Tinggi Town)



Conclusion

CONCLUSION

- For a flood risk management plan to be successful, it needs an integrated participation from various agencies.
- The benefits of the integration of flood risk management into wider development management, urban planning and climate change adaptation are clear.
- It must be recognized that even repeated awareness campaigns, flood warnings and general advice will not always generate the required actions.
- There is a need to strike a balance between structural and non-structural measures in order to gain the most successful long-term flood risk management strategies.
- Understanding the required resources, the best and worst case scenarios is pertinent in making better decisions.

Thank You