

FLOOD HAZARD MAPPING USING TWO-DIMENSIONAL RIVER MODELLING FOR SUNGAI MUAR, JOHOR

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NAHRIM**

**COLLOQUIUM ON R & D IN FLOOD PLAIN MANAGEMENT
MARRIOTT HOTEL, PUTRAJAYA
8 DECEMBER 2010**



**NATIONAL HYDRAULIC RESEARCH INSTITUTE OF MALAYSIA (NAHRIM)
MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT (NRE)**



OUTLINE

- Project Details
- Methodology
 - Data Collection
 - Data Analysis
- Model Set-Up
- Model Calibration
- Model Verification
- Model Simulation
- Results
- Conclusion

PROJECT DETAILS

1. LOCATION

:Sg. Muar River Basin, Johor

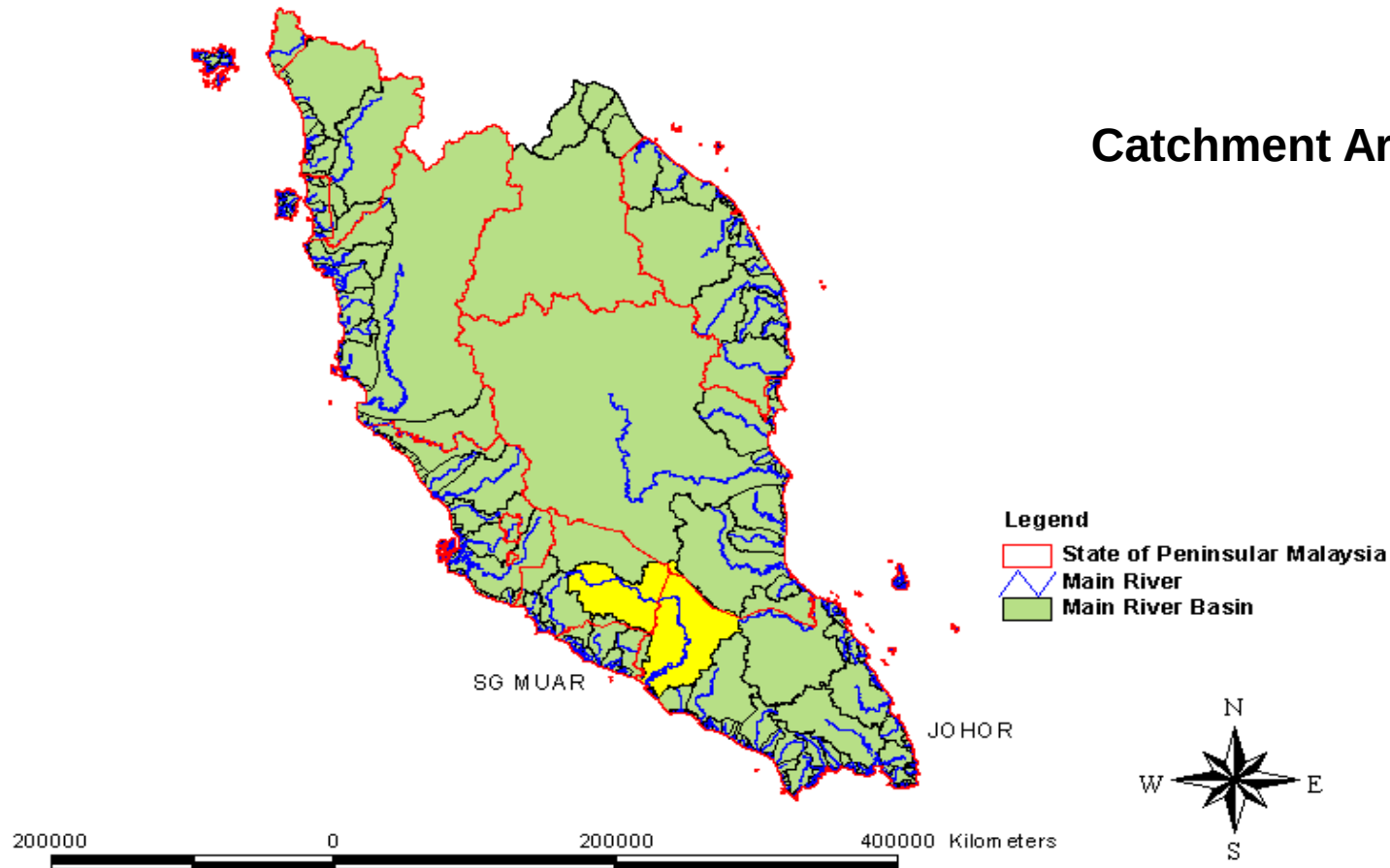
2. PROJECT DURATION: October 2009 – December 2010

3. OBJECTIVES :

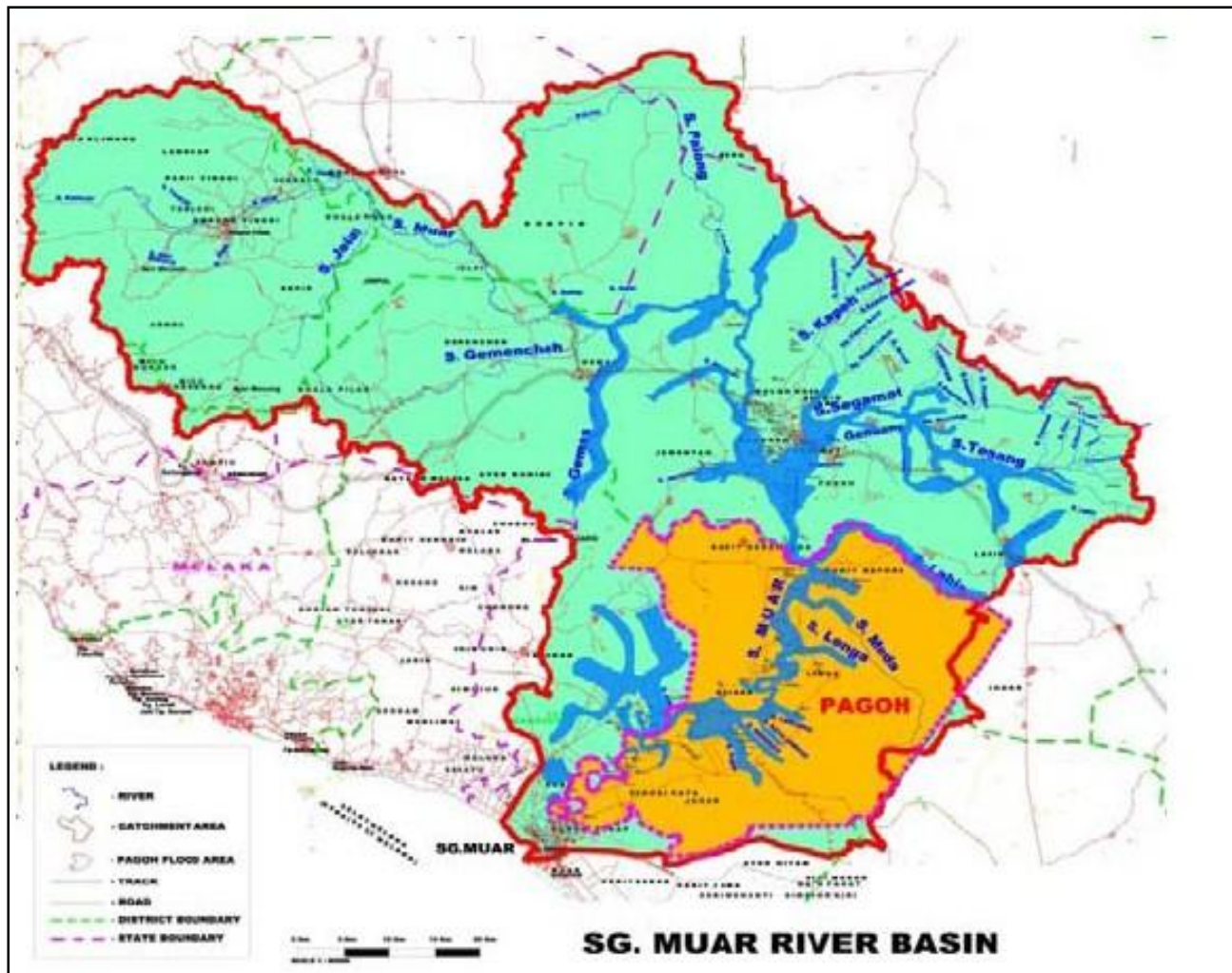
- To develop a 2-Dimensional River Model covering flood plain of Muar River for distance from Kuala Pilah down to the river mouth (Distance of 280 km)
- To generate flood risk map for various return periods (2-,5-, 10-, 20-, 50- and 100-year)

PROJECT SITE

Catchment Area: 6149 km²



FLOOD PRONE AREAS



FLOOD PHOTOS



JOHOR: The overflowing Sungai Kesang in Muar forced thousands of Muar residents to evacuate their homes on Dec 24, 2006. NST pix by Rosdan Wahid.



JOHOR: Submerged vehicles were everywhere in Panchor, near Muar on Dec 24, 2006, as floodwaters made it difficult to remove the vehicles. NST pix by Junita Mat Rashid.



JOHOR: Railmen checking out the damage caused by the floods in Segamat. NST Pix



JOHOR: Newlyweds Haw Zhen Yap and Choo Kuan Yee proceeding with their marriage during the floods in Muar, Johor

FLOOD PHOTOS



JOHOR: Mahat Haron, 51, (in the foreground) taking a dip in the floodwaters with his family members. When the picture was taken, the water measured at 4m deep. NST pix by Fathil Asri.



JOHOR: Volunteers keep on sending food supplies to victims stranded in Kampung Batu Badak in Segamat on Dec 24, 2006, even at night. NST pix by Shahrul M. Zain.

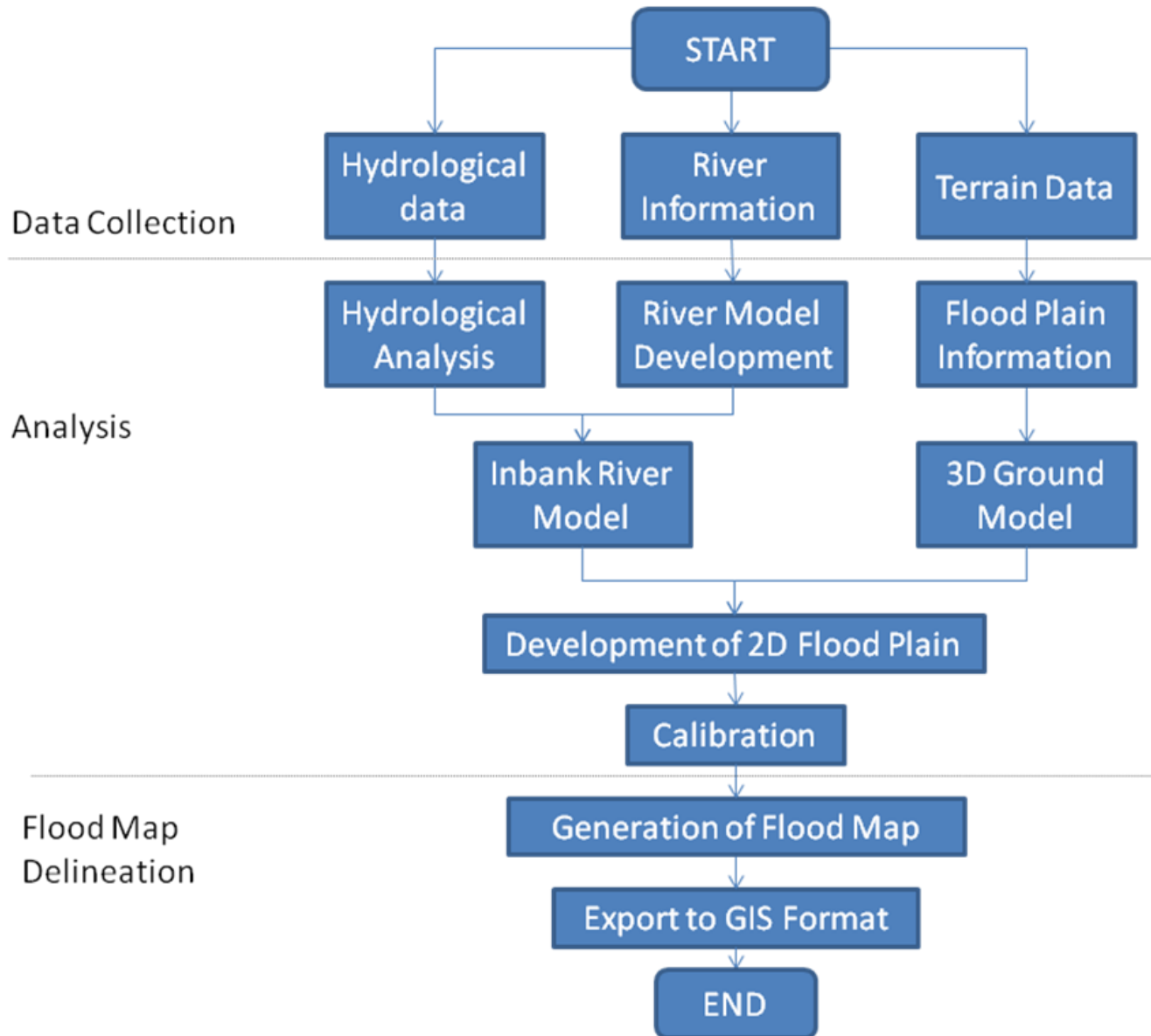


JOHOR: Faizal Salleh, 31, doing his part in discarding pieces of wood which ended up inside the padi field in Kampung Kesang Gate, Muar as a result of the overflowing Sungai Kesang on Dec 24, 2006. NST pix by Rosdan Wahid.

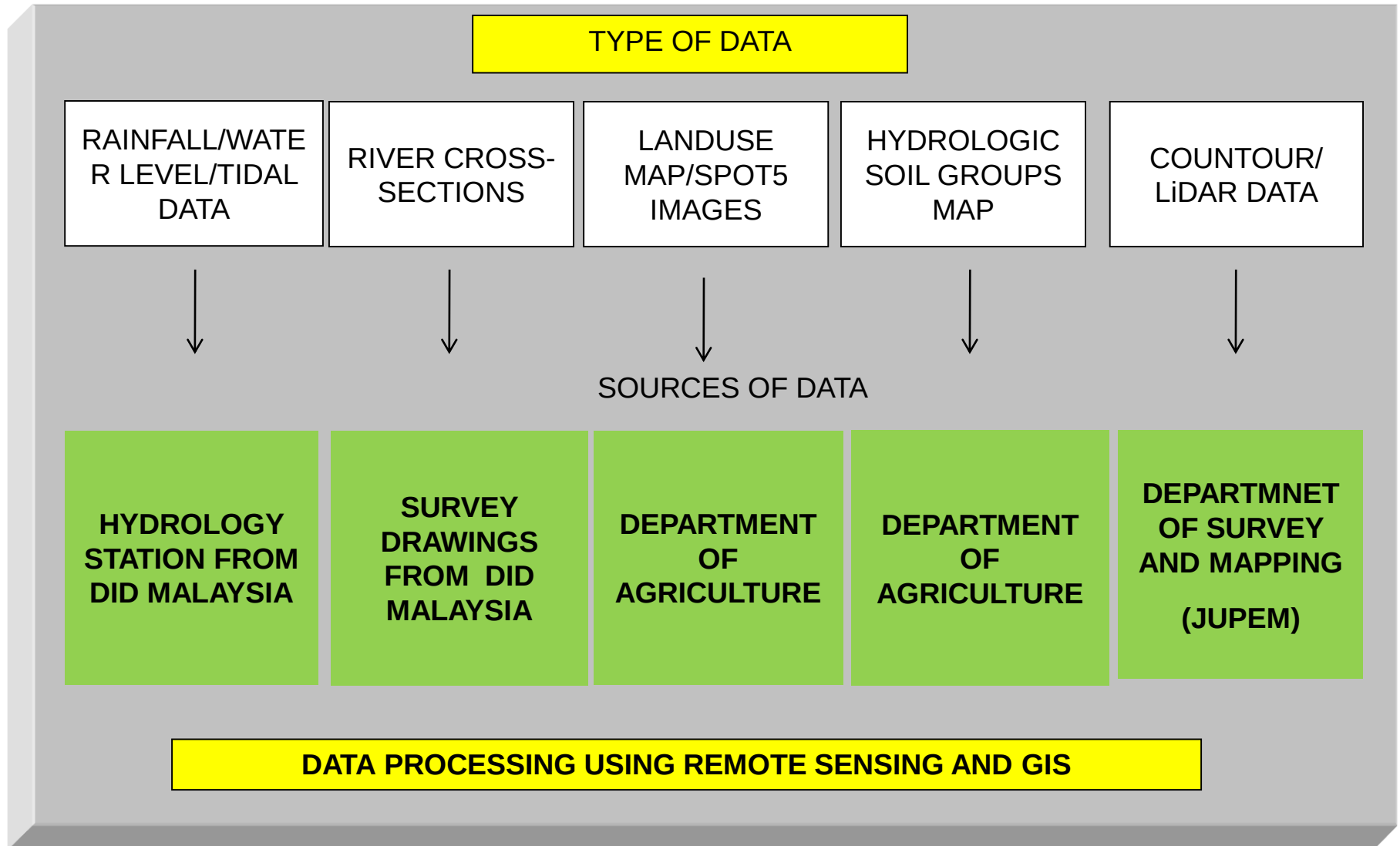


JOHOR: This family resolved to wade through the floodwaters which have resulted in the closure of Jalan Segamat-Muar in Kampung Rawang and Pantai Layang in Muar. NST pix by Rosdan Wahid.

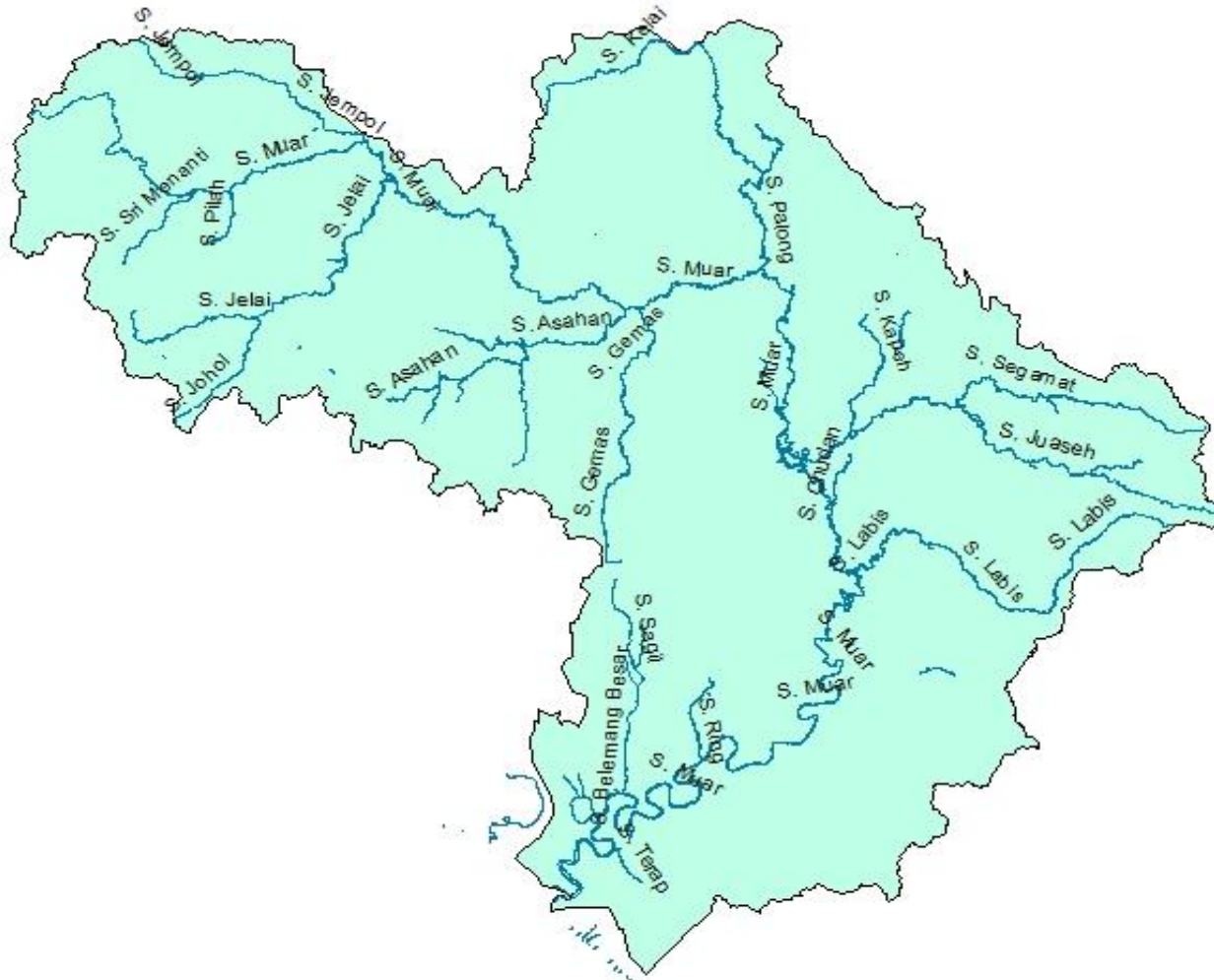
METHODOLOGY



DATA COLLECTION



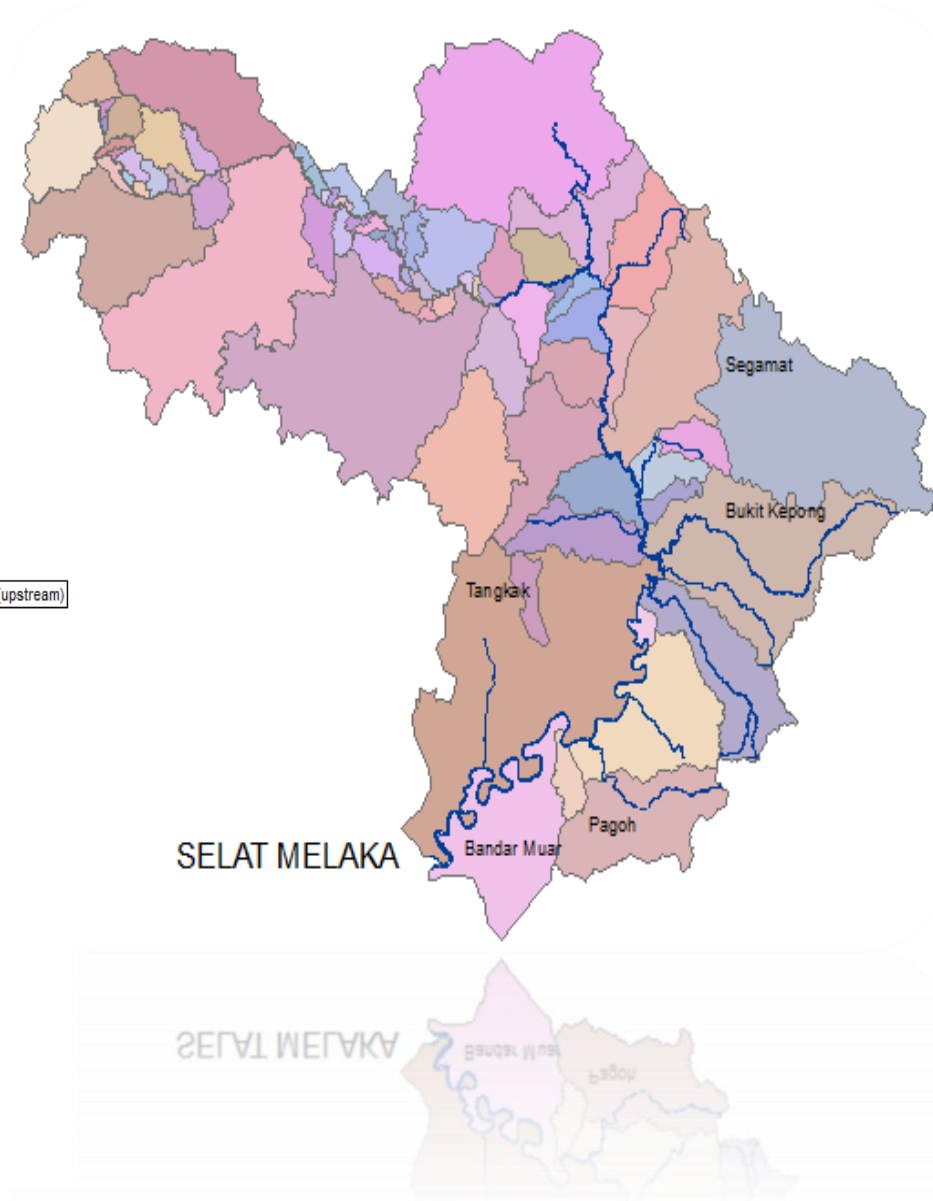
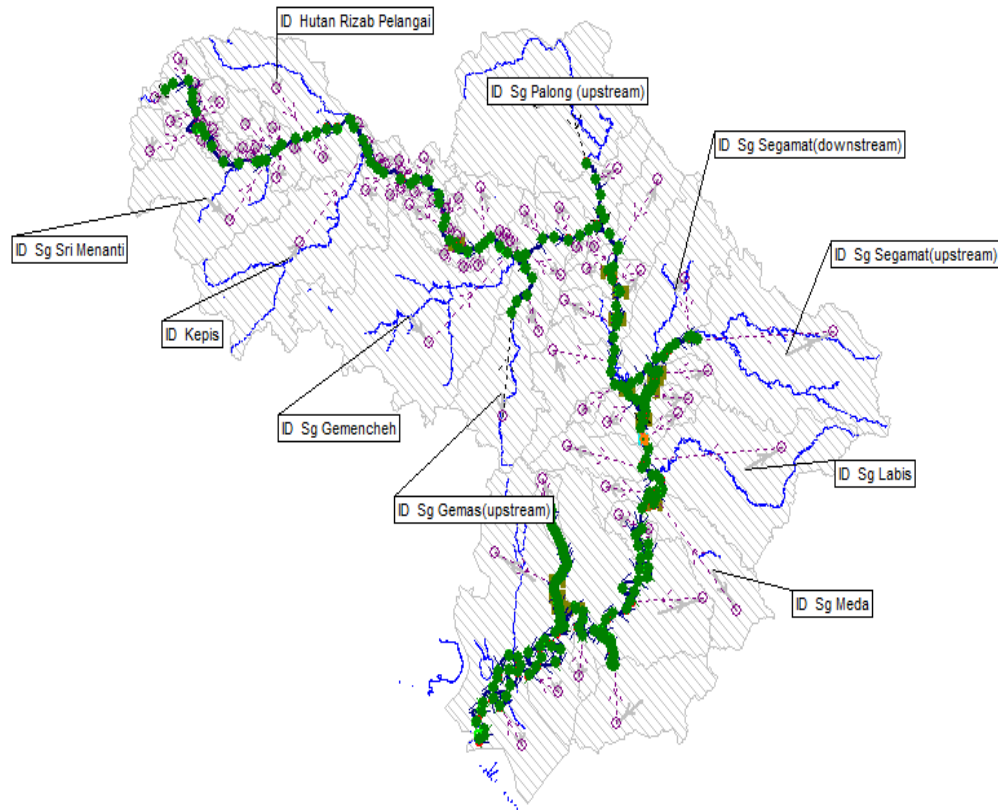
RIVER SYSTEM



Main river
tributaries:
Sg Ring
Sg Gemas
Sg Chodan
Sg Pagoh
Sg Segamat
Sg Palong

SG MUAR SUBCATCHMENT

- Catchment
 - Area
 - properties



SUB-CATCHMENTS

Bil	Kawasan Tadahan	Keluasan (ha)	Peratusan (%)
1	Sg Muar	145886.38	24.16
2	Sg Ayer Kuning	2086.24	0.35
3	Sg Batu Pulai	609.52	0.10
4	Sg Bemban	453.83	0.08
5	Sg Bugis	2684.81	0.44
6	Sg Chodan	7924.79	1.31
7	Sg Gali	3263.30	0.54
8	Sg Gemas	24055.20	3.98
9	Sg Gemencheh	51372.44	8.51
10	Sg Jemapoh	1453.57	0.24
11	Sg Kasai	172.64	0.03
12	Sg Kelebang	1765.17	0.29
13	Sg Keluang	3060.03	0.51
14	Sg Keratoh	1460.96	0.24
15	Sg Kopah	258.97	0.04
16	Sg Labis	39027.25	6.46
17	Sg Lubok Long	269.96	0.04
18	Sg Meda	16839.60	2.79
19	Sg Membaju	8882.84	1.47
20	Sg Merlanau	5923.94	0.98

Bil	Kawasan Tadahan	Keluasan (ha)	Peratusan (%)
21	Sg Mulan	3883.91	0.64
22	Sg Pagoh	38318.73	6.35
23	Sg Palong	59525.19	9.86
24	Sg Parit	957.02	0.16
25	Sg Paya Mengkuang	1611.56	0.27
26	Sg Penyalai	4184.85	0.69
27	Sg Pondong Bayu	975.63	0.16
28	Sg Ring	47200.93	7.82
29	Sg Salak	4728.09	0.78
30	Sg Santi	4731.83	0.78
31	Sg Segamat	73486.63	12.17
32	Sg Semaruk Hilir	4057.49	0.67
33	Sg Senama	2500.46	0.41
34	Sg Sepang Loi	11132.72	1.84
35	Sg Sikunanti	1900.62	0.31
36	Sg Sri Menanti	22996.00	3.81
37	Sg Sungkak	2671.06	0.44
38	Sg Talat	1520.75	0.25
Total		603834.91	100.00

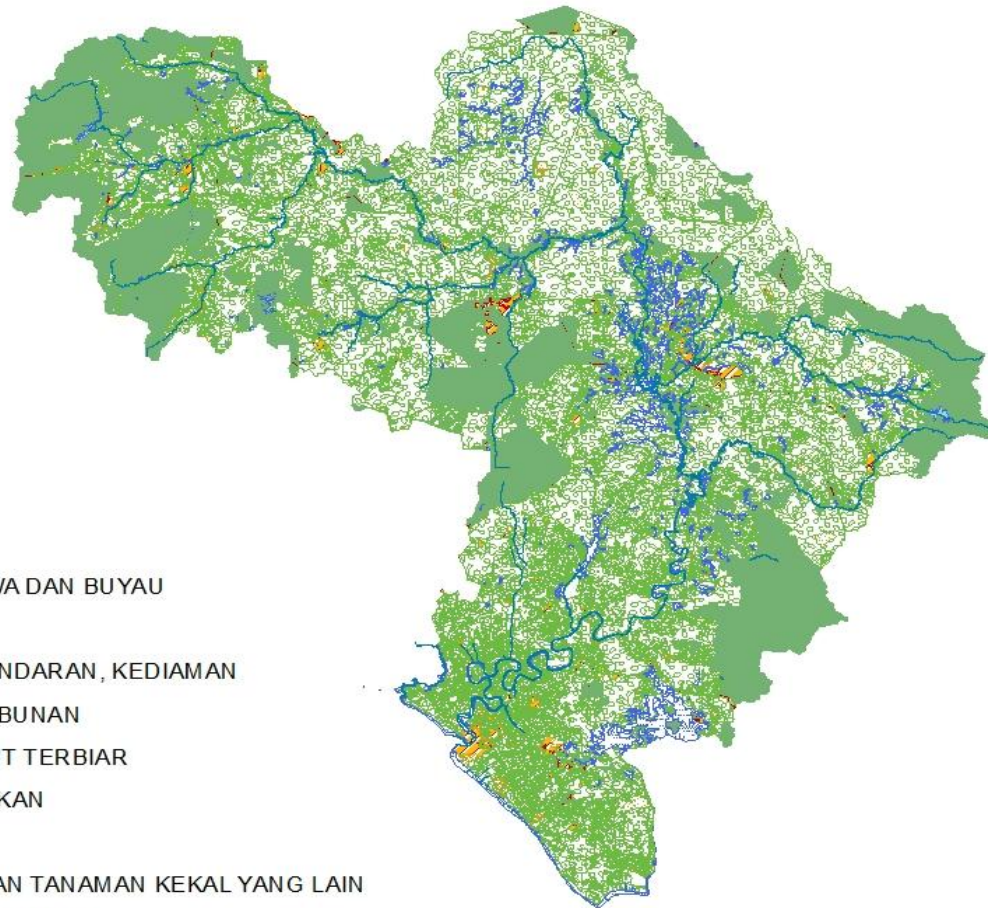
LANDUSE MAP

Legend

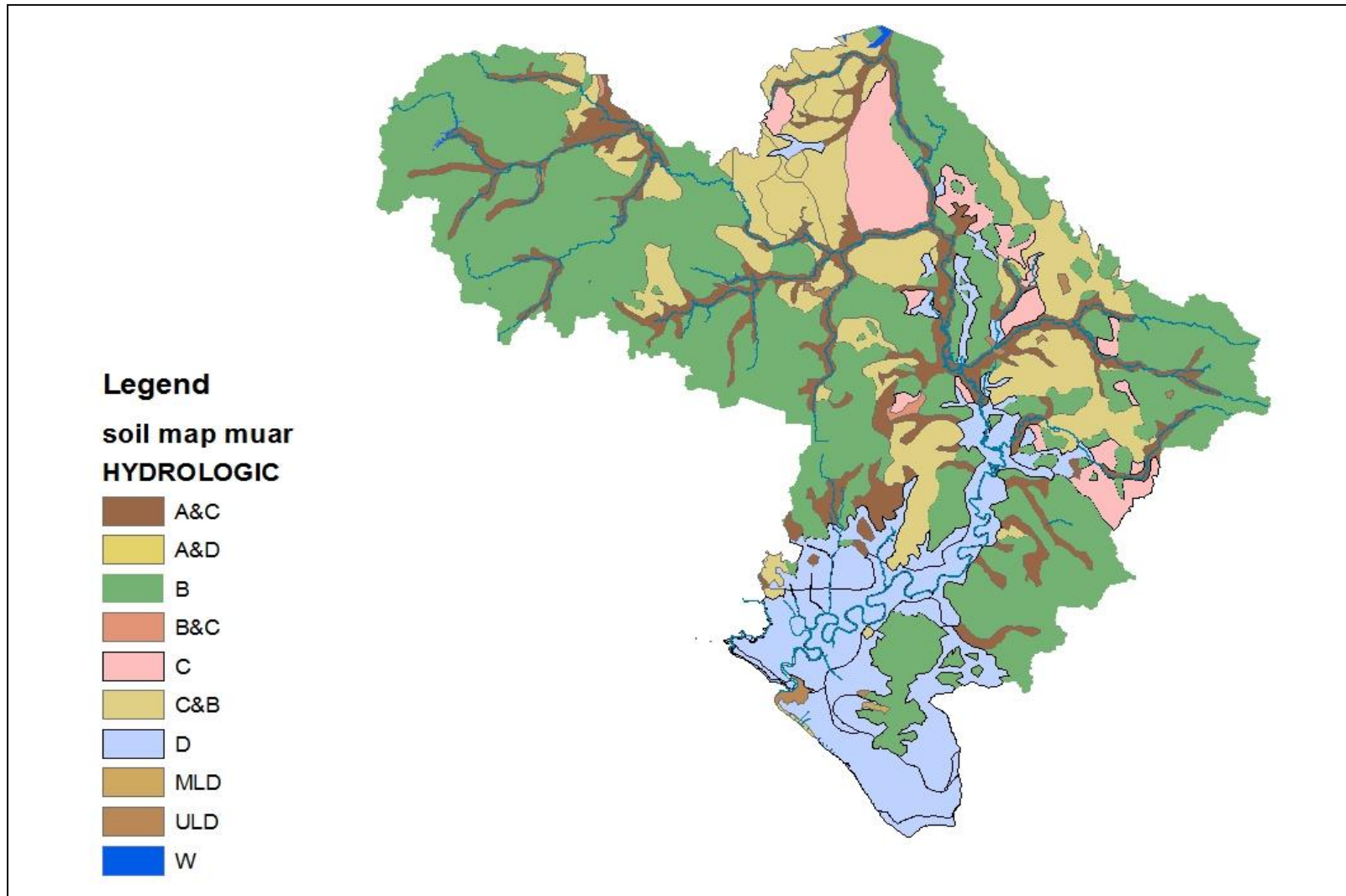
landuse_muar

KATEGORI

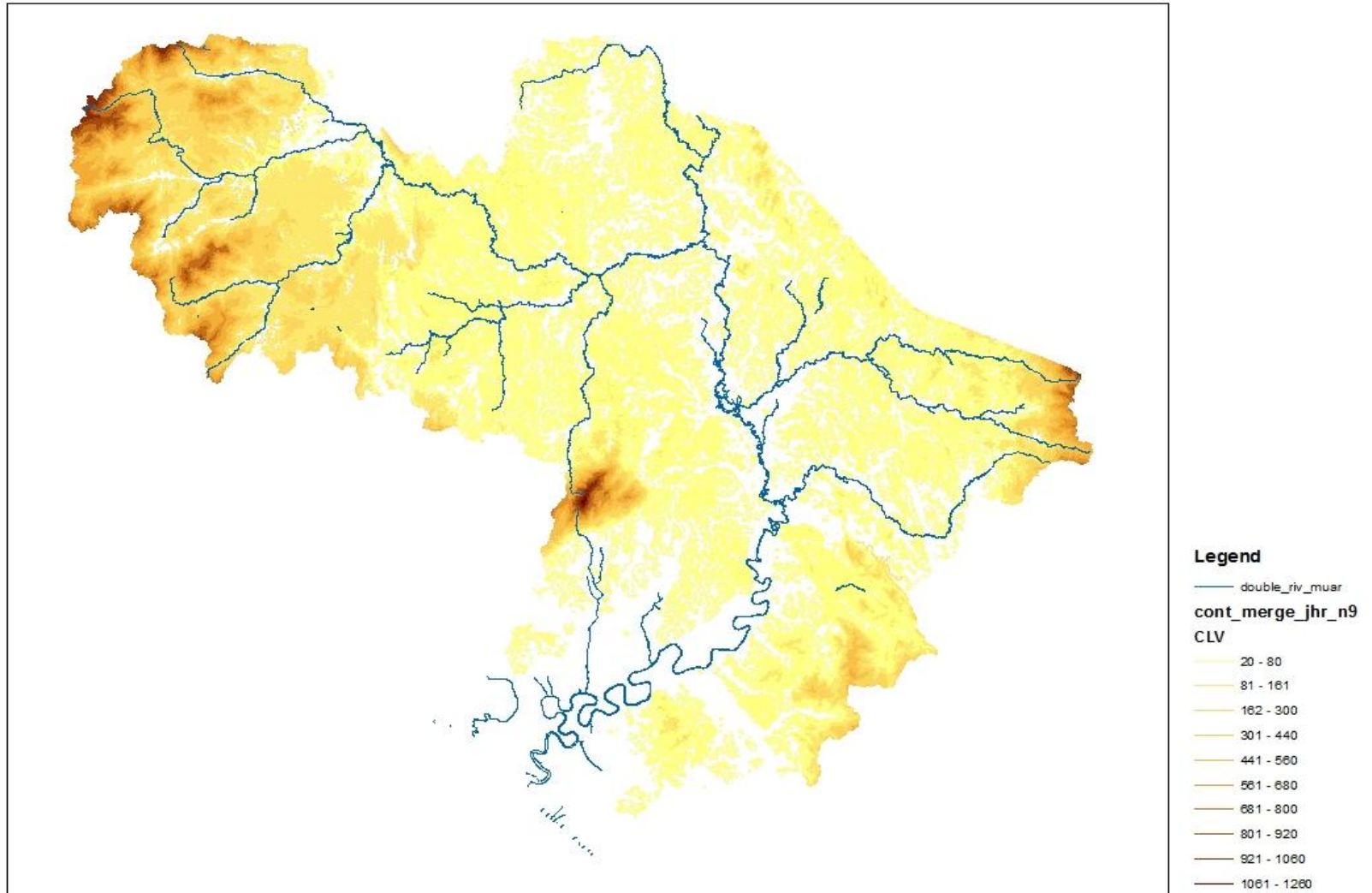
-  BADAN AIR
-  HUTAN PAYA, RAWA DAN BUYAU
-  KAWASAN HUTAN
-  KAWASAN PERBANDARAN, KEDIAMAN
-  KAWASAN PERKEBUNAN
-  KAWASAN RUMPUT TERBIAR
-  KAWASAN TERNAKAN
-  PELBAGAI
-  POKOK, PALMA DAN TANAMAN KEKAL YANG LAIN
-  TANAMAN SINGKAT MASA



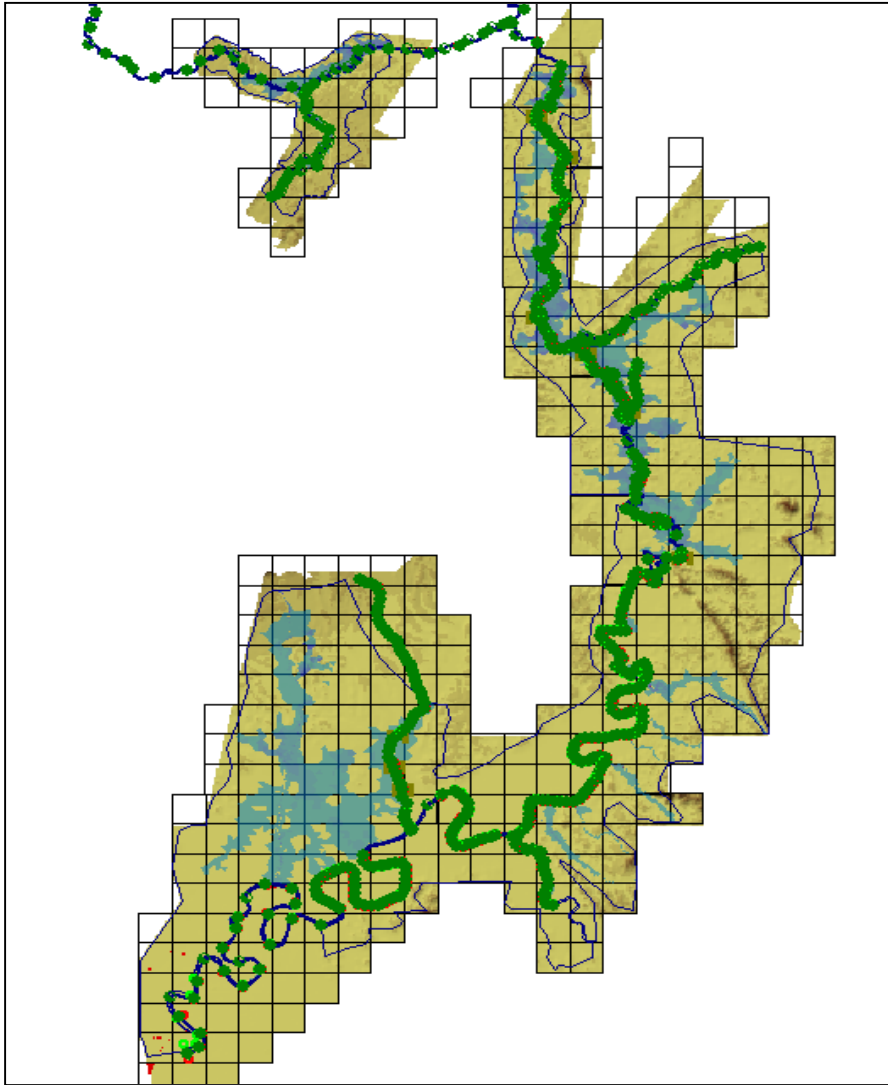
HYDROLOGIC SOIL GROUPS MAP



CATCHMENT WITH CONTOUR



DEM USING LiDAR DATA



LiDAR coverage

➤ Size: 1464 km²

➤ Total Parcels = 530
(346 used in model)

SITE VISIT (28-29 DEC 09 & 22-23 FEB 10)



Flood Prone area at Kuala Pagoh



High Tide Condition at Kg Kundang Ulu



Flood Prone area at Kg Kundang Ulu



Flood Prone area at Gersik

SITE VISIT (28-29 DEC 09 & 22-23 FEB 10)



Sungai Muar bridge at
Kg Tebing Tinggi (Segamat)



Sungai Muar bridge at Bukit Kepong



Sungai Muar bridge at Buloh Kasap (Segamat)



Sungai Ring bridge

SITE VISIT (28-29 DEC 09 & 22-23 FEB 10)



Sungai Ring Gate (Agriculture Purposes)



Sungai Muar at Bukit Kepong



Sungai Muar bridge at Tumang (Segamat)

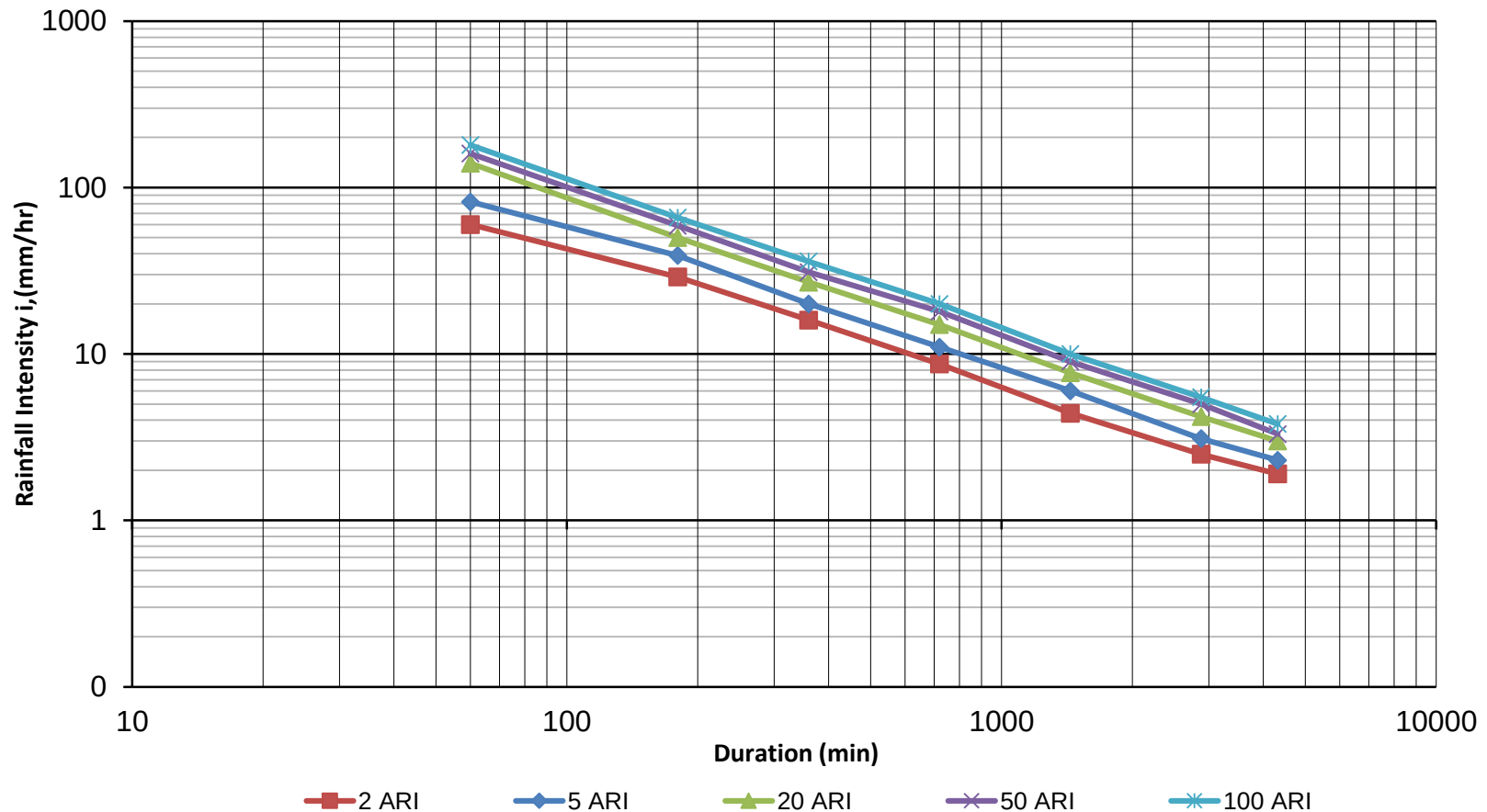


HYDROLOGICAL STATION



FREQUENCY ANALYSIS

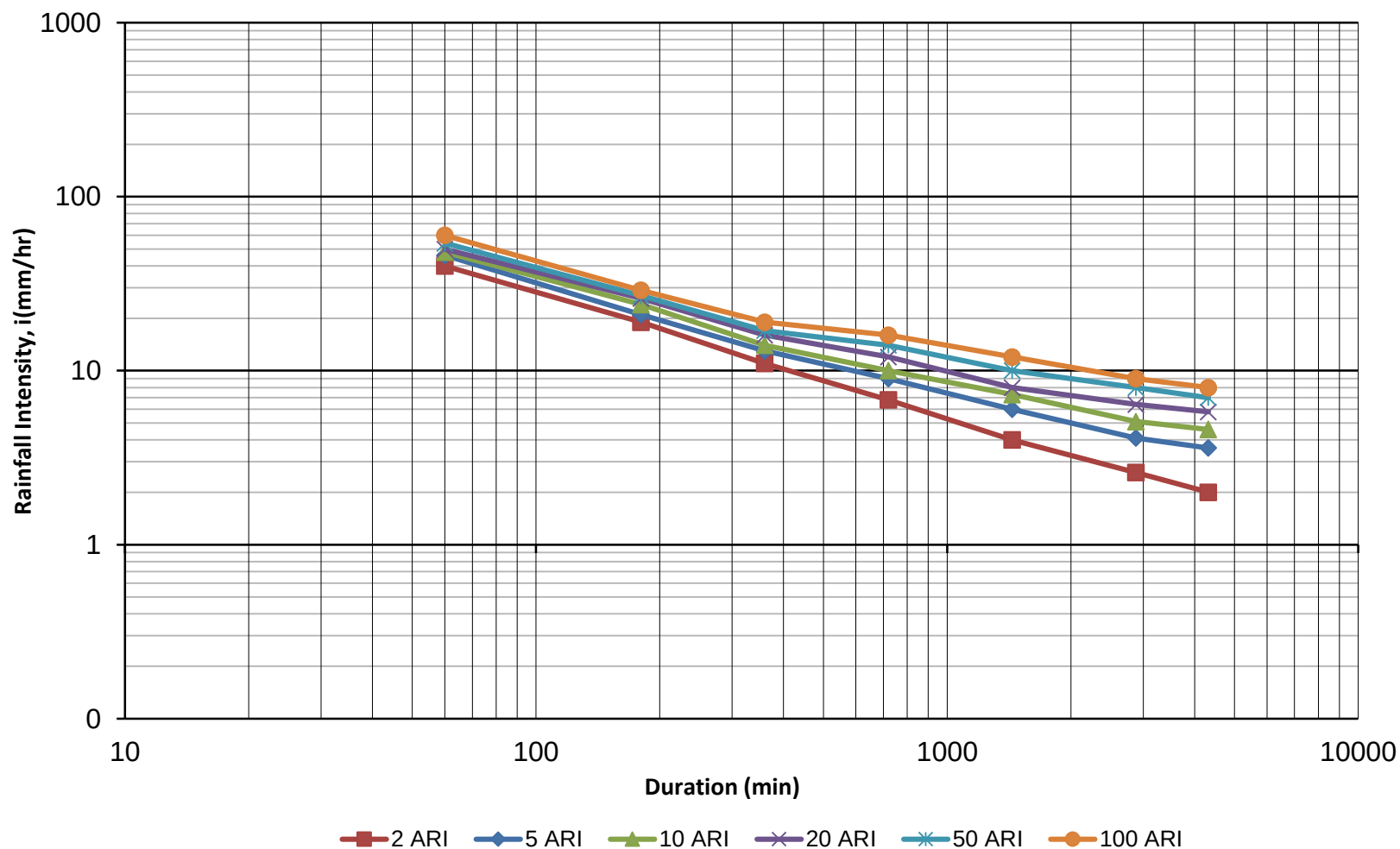
IDF Curve - Station no 2025001-Tanjung Agas Control Gate (1975-2009)



Gumbel (Extreme value Type 1) > Two parameters (sample means and sample standard deviation)

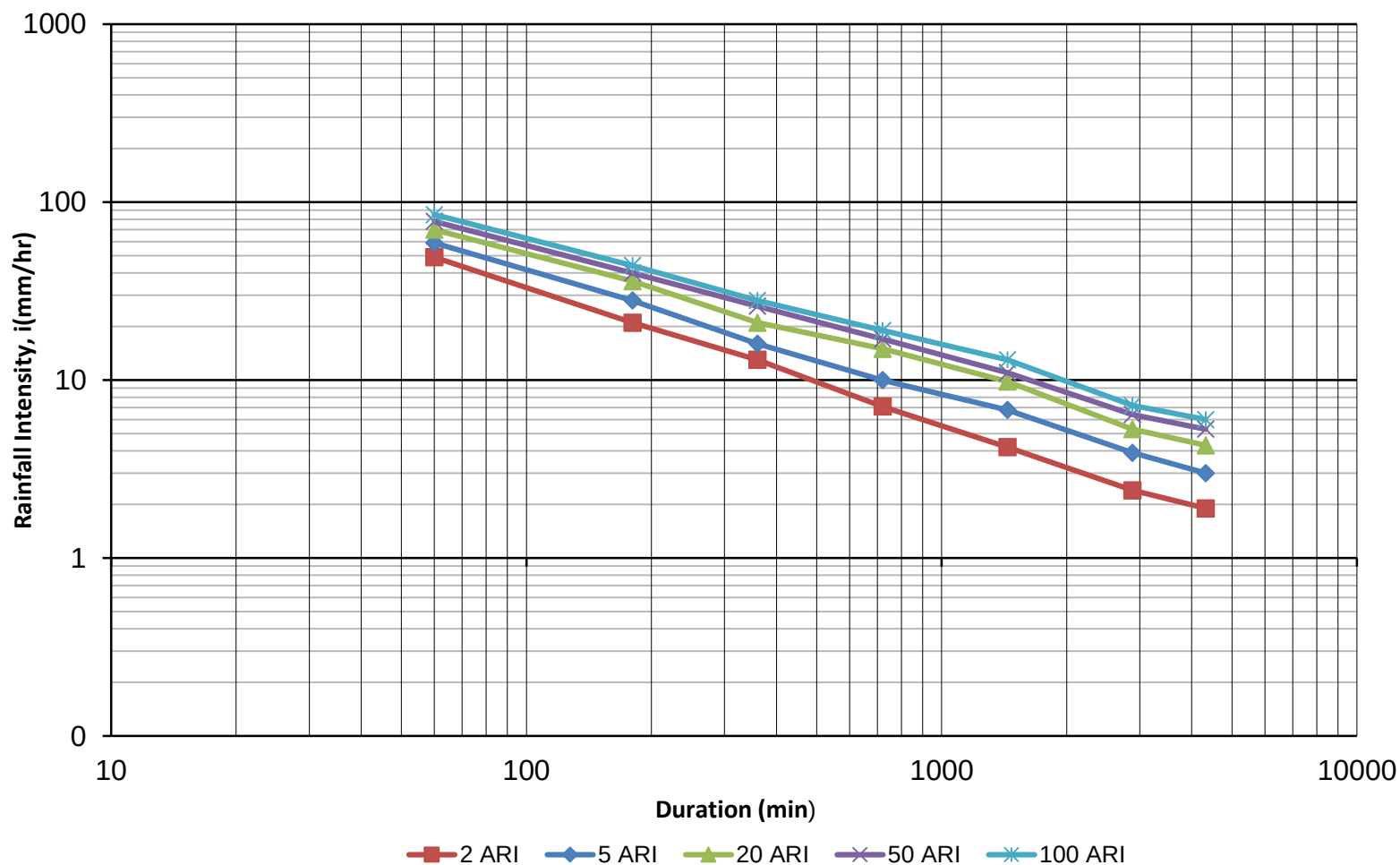
FREQUENCY ANALYSIS

IDF Curve - Station no 2025001-Station no 2330009- Sg Labis (1971-2009)



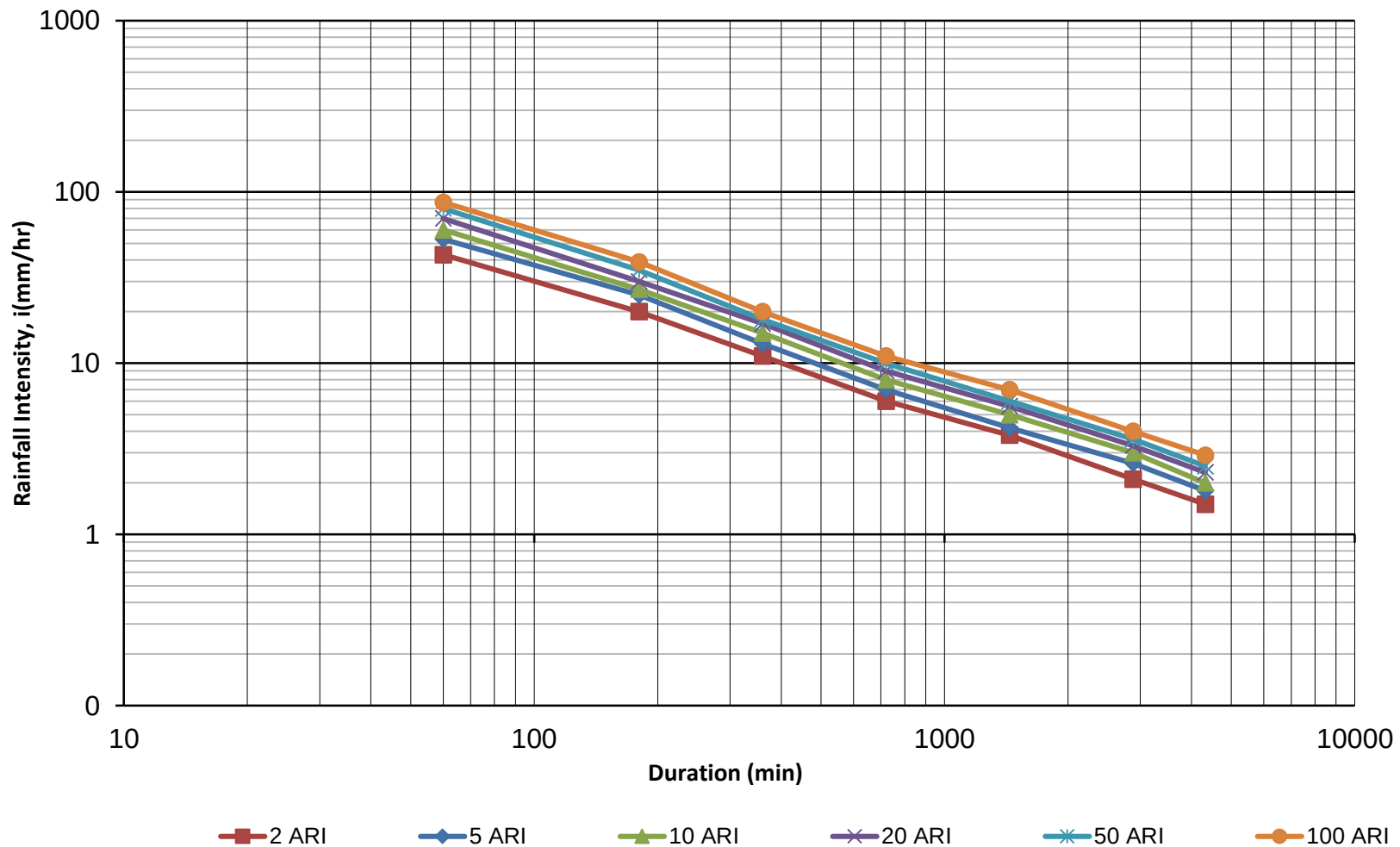
FREQUENCY ANALYSIS

IDF Curve - Station no 2528012- Rumah Tapis at Segamat (1971-2009)



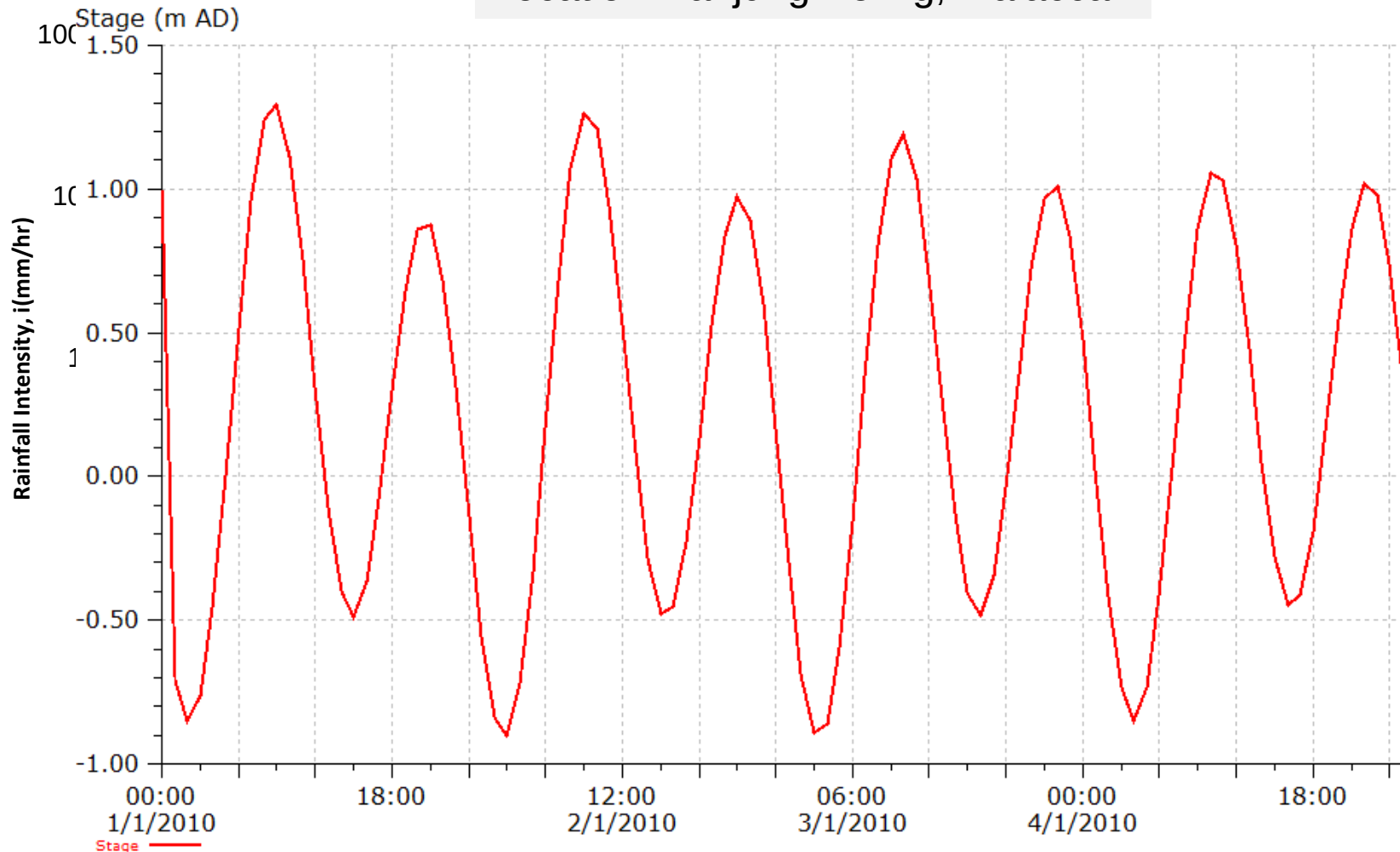
FREQUENCY ANALYSIS

IDF Curve - Station no 2722002- Kg Sawah Lebar at Negeri Sembilan (1971-2009)



TIDAL DATA

Location: Tanjung Keling, Malacca



Tide Table : National Hydrographic Centre, Royal Malaysian Navy

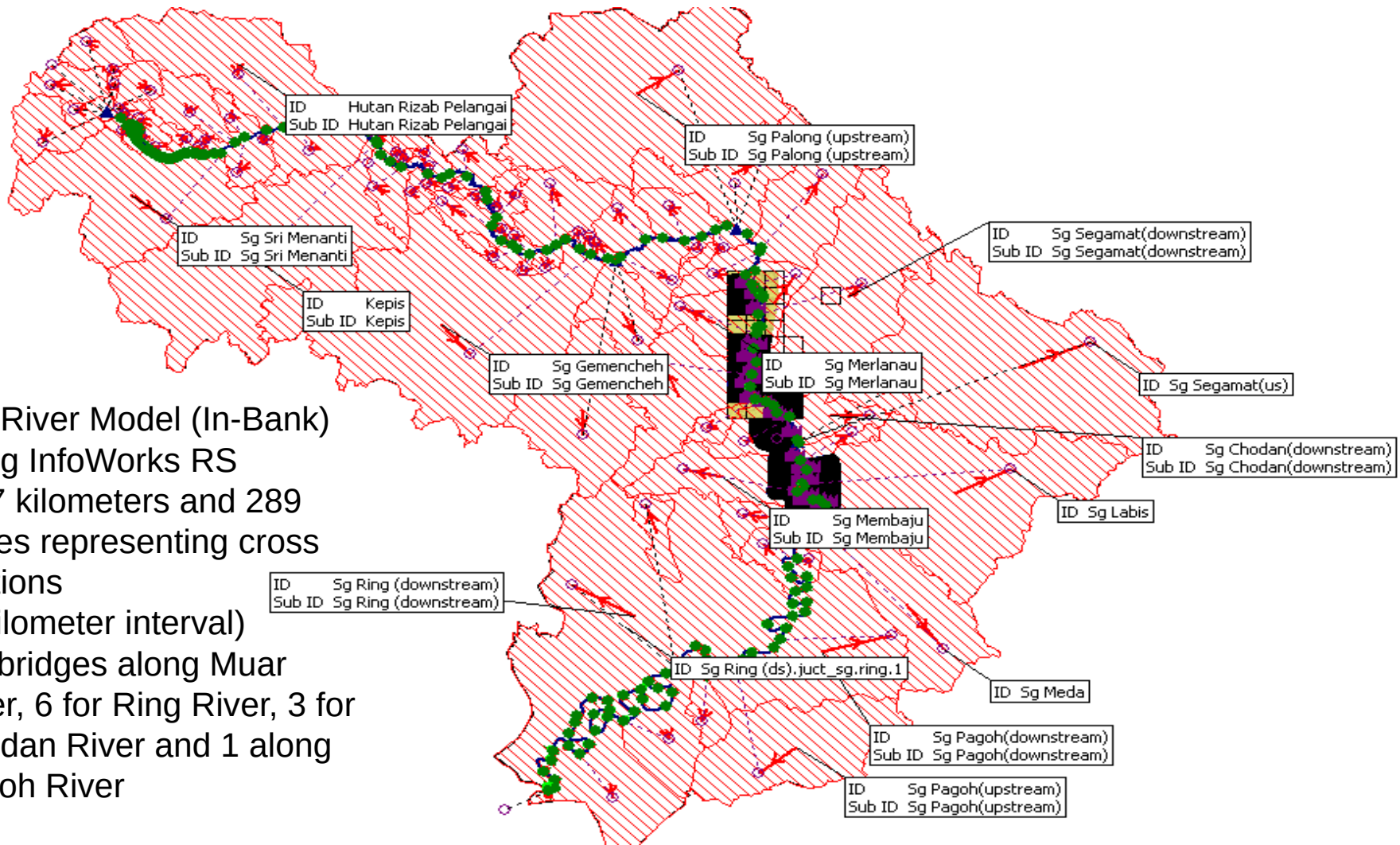
CURVE NUMBER

Node	Curve Number	Event Type
Bandar Muar	85	US SCS Boundary
Batu Kadam	70	US SCS Boundary
Dummy flow G	70	Flow - Time
Dummy P	70	Flow - Time
Dummy Pgh	70	Flow - Time
Dummy R	70	Flow - Time
Dummy S	70	Flow - Time
Dummy u/s	70	Flow - Time
Dummy upstream	70	Flow - Time
Gemas	78	US SCS Boundary
Gerisek	75	US SCS Boundary
Hutan Rizab Berembun	58	US SCS Boundary
Hutan Rizab Pdg Selatan	68	US SCS Boundary
Hutan Rizab Pelangai	65	US SCS Boundary
Jelai	76	US SCS Boundary
Jementah	65	US SCS Boundary
Kaw Berkelompok Buluh Kasap	77	US SCS Boundary
Kawasan Orang Asli	66	US SCS Boundary
Kemajuan Tanah Awat Satu	78	US SCS Boundary
Kemajuan Tanah Palong Timur	77	US SCS Boundary
Kemajuan Tanah Pasir Besar	66	US SCS Boundary
Kepis	70	US SCS Boundary
Kg Baning	65	US SCS Boundary
Kg Jawa	83	US SCS Boundary
Kg Kelebang	65	US SCS Boundary
Kg Langkap	58	US SCS Boundary
Kg Mati	61	US SCS Boundary

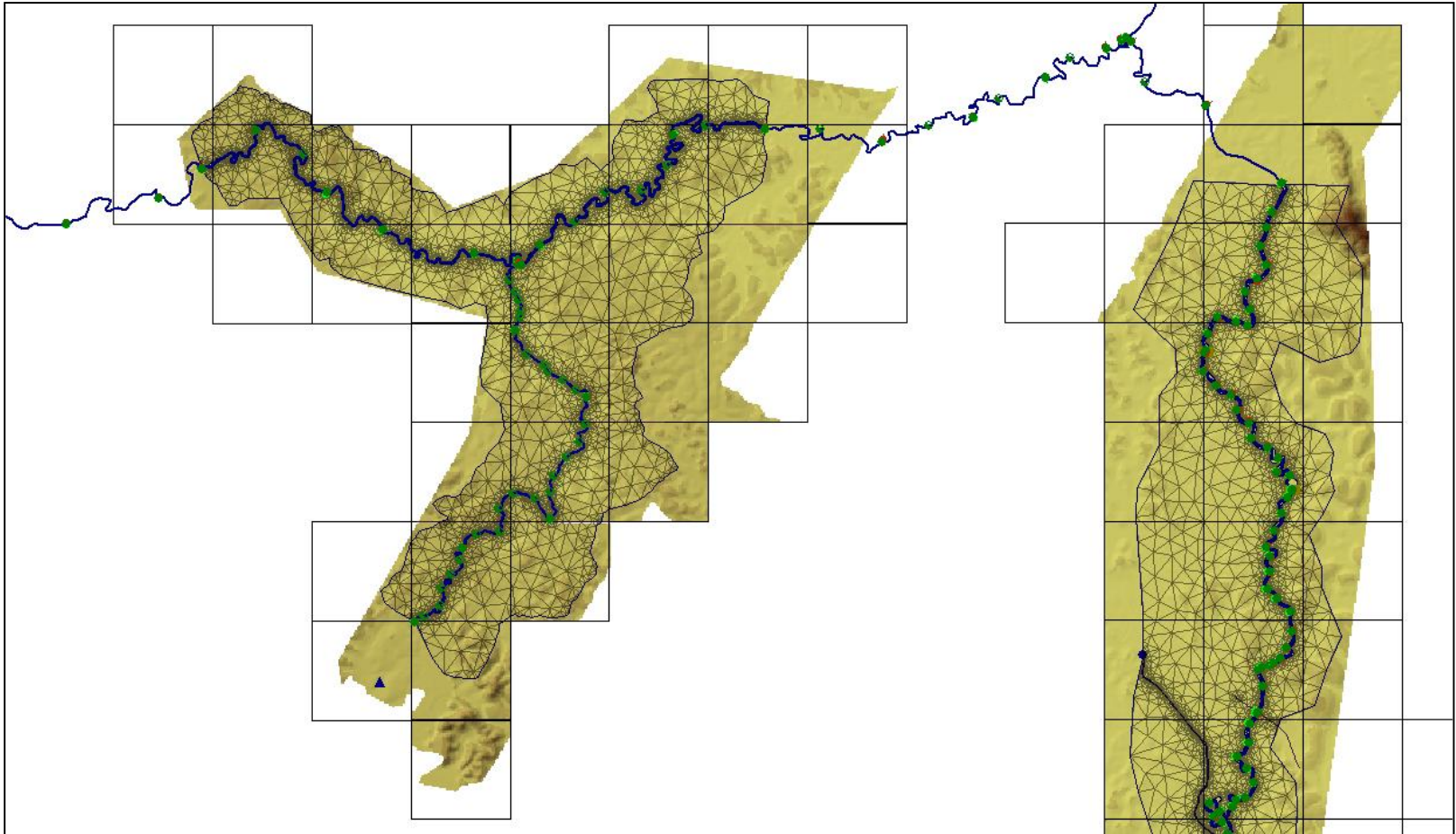
Node	Curve Number	Event Type
Kg Pasir Besar	85	US SCS Boundary
Kg Purun	64	US SCS Boundary
Kg Talang Tengah	61	US SCS Boundary
Kuala Pilah	74	US SCS Boundary
Ladang Balamah	84	US SCS Boundary
Ladang Batang Jelai	72	US SCS Boundary
ladang Bungah Puteri	67	US SCS Boundary
Ladang Getah	78	US SCS Boundary
Ladang Goodwood	65	US SCS Boundary
Ladang Mallika Bahau	70	US SCS Boundary
Ladang Orang Asli	64	US SCS Boundary
Ladang Paya Lang bhgn Tumang	79	US SCS Boundary
Ladang Raja Baiyah	62	US SCS Boundary
Ladang Sialang	66	US SCS Boundary
Ladang Union	64	US SCS Boundary
Parit Tinggi	57	US SCS Boundary
Rizab Melayu Kuala Gemas	69	US SCS Boundary

MUAR RIVER HYDRODYNAMIC MODEL (1-D)

1 D River Model (In-Bank)
using InfoWorks RS
-317 kilometers and 289
nodes representing cross
sections
(1 kilometer interval)
-10 bridges along Muar
River, 6 for Ring River, 3 for
Chodan River and 1 along
Pagoh River



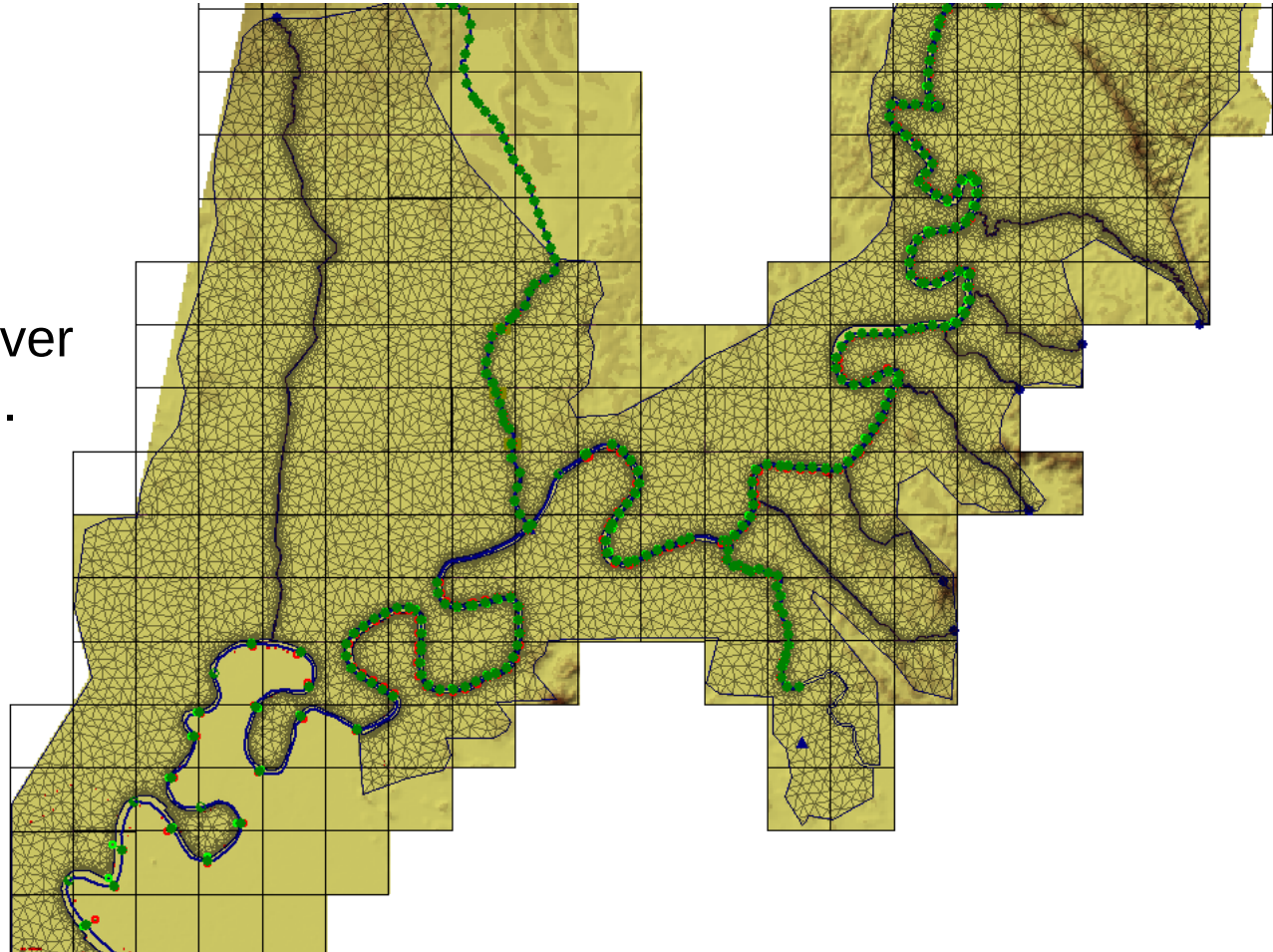
MUAR RIVER HYDRODYNAMIC MODEL (2-D)



Flood plain represented by 2D mesh – (Upstream)

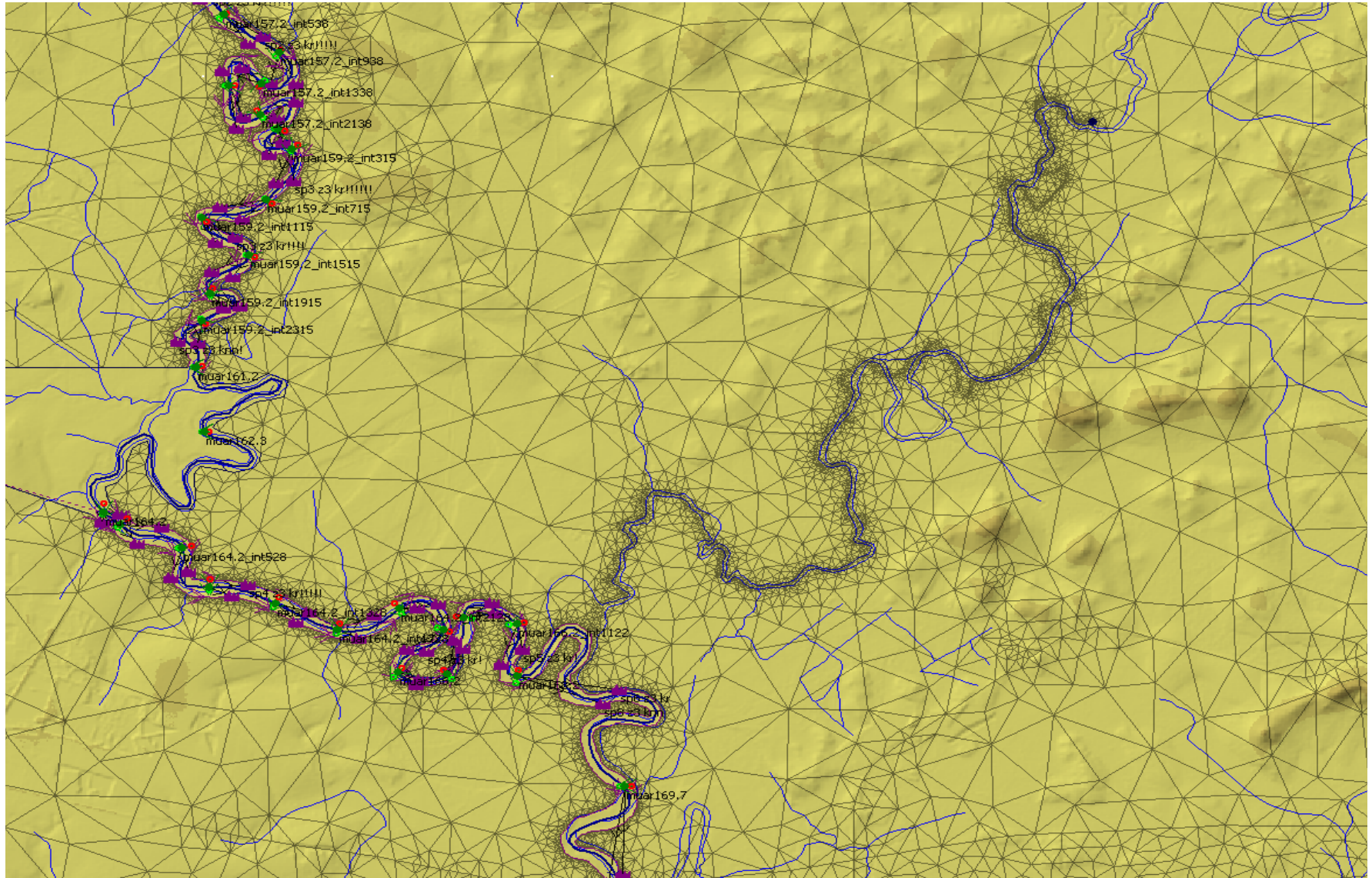
MUAR RIVER HYDRODYNAMIC MODEL (2-D)

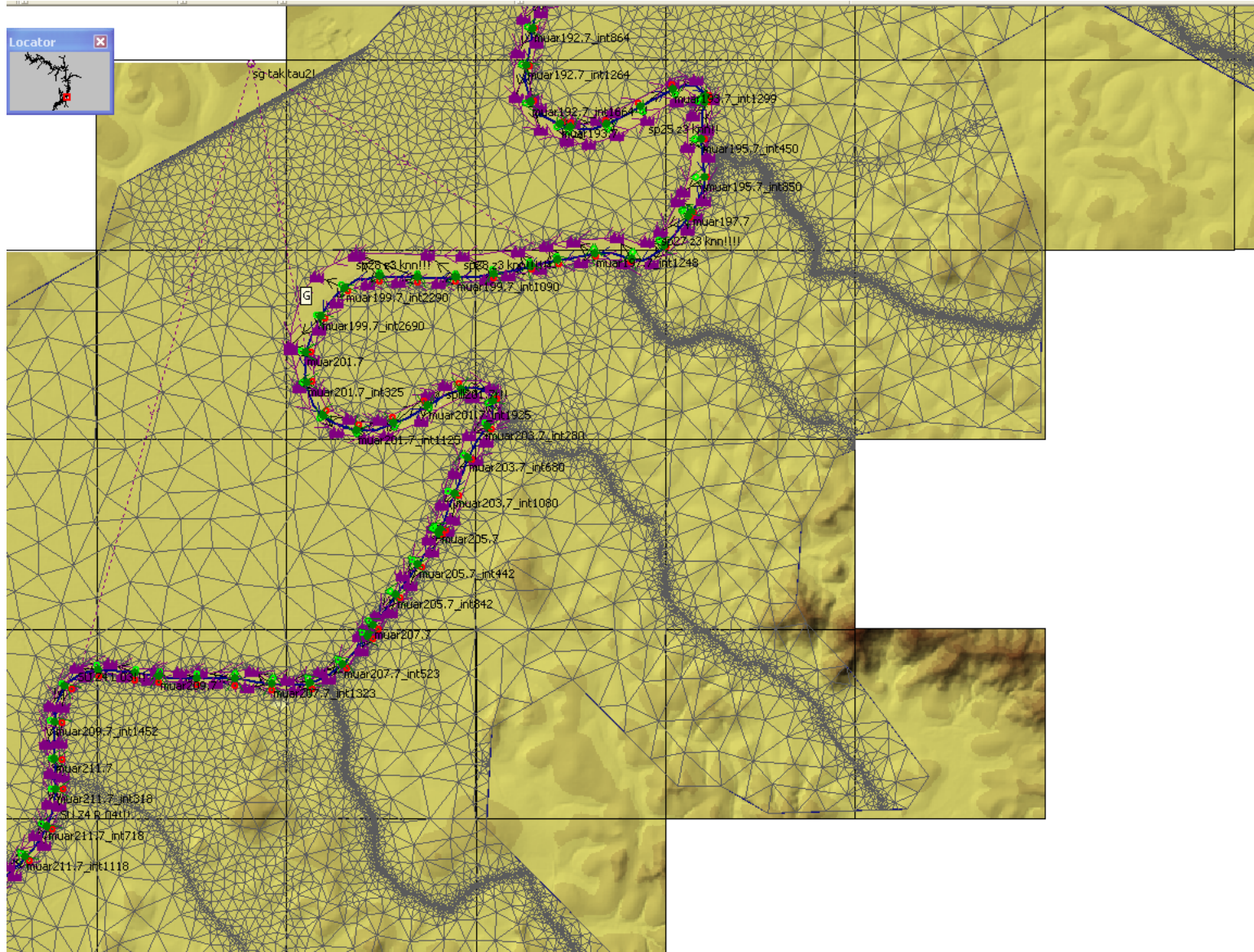
- The 2Dmesh created about 300,000
- 800 spill unit connecting main river and the flood plain.



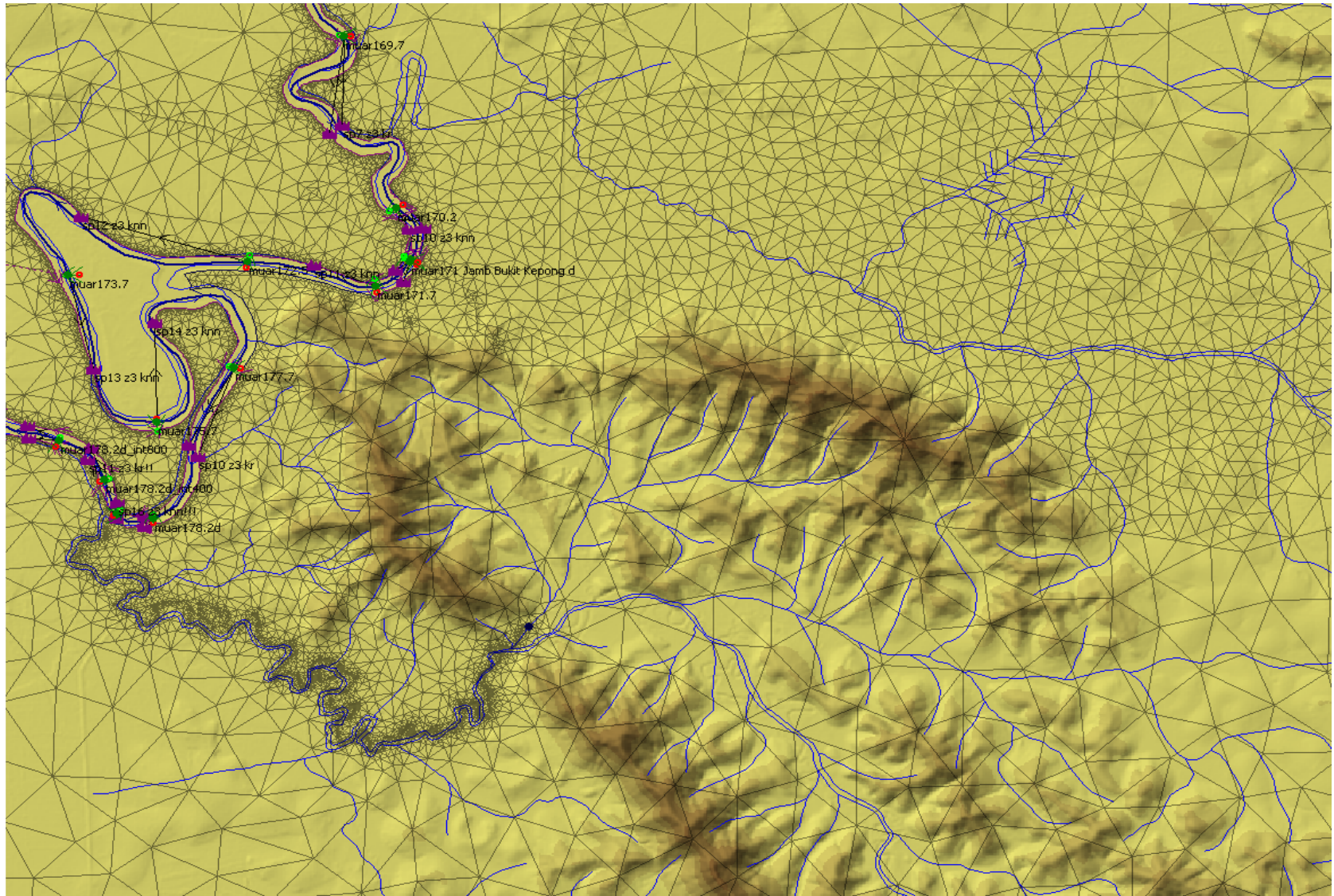
Flood plain represented by 2D mesh – (Downstream)

SMALL RIVER BY MESHES AND CONNECTED WITH POINT SOURCES

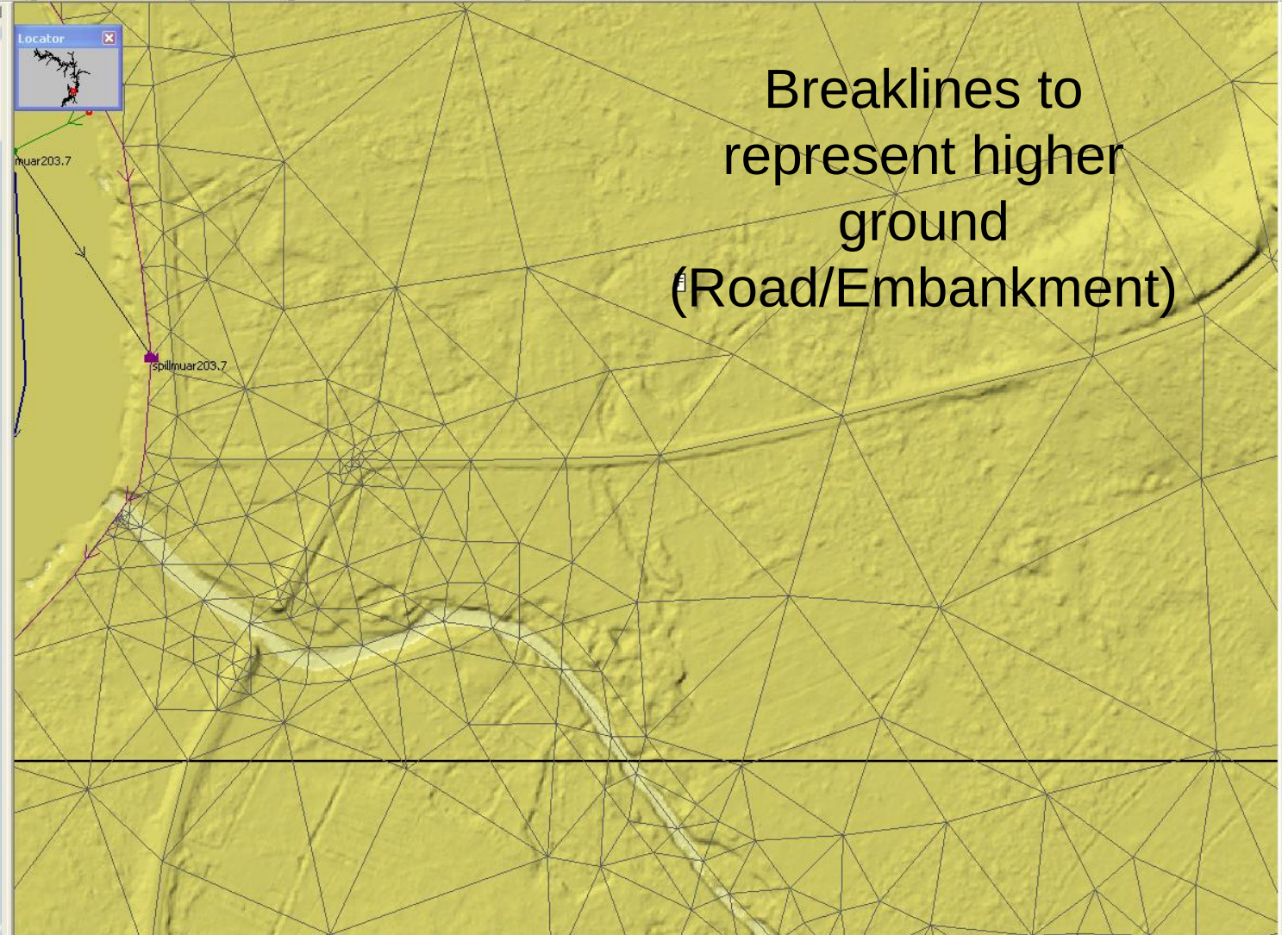
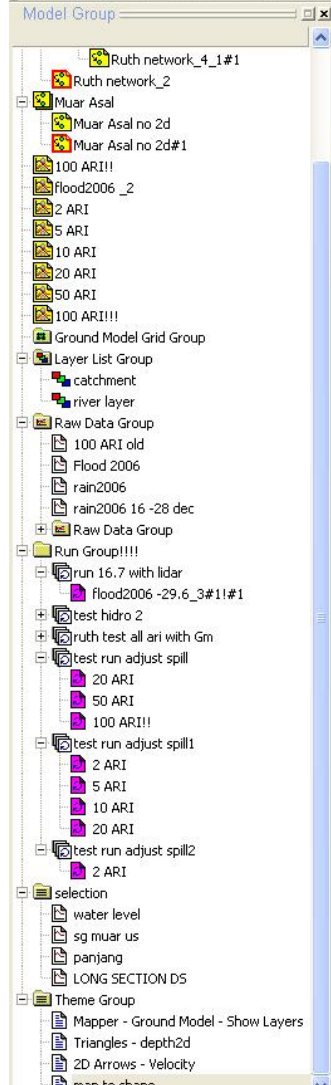




CRITICAL AREA REPRESENTED BY SMALL MESH

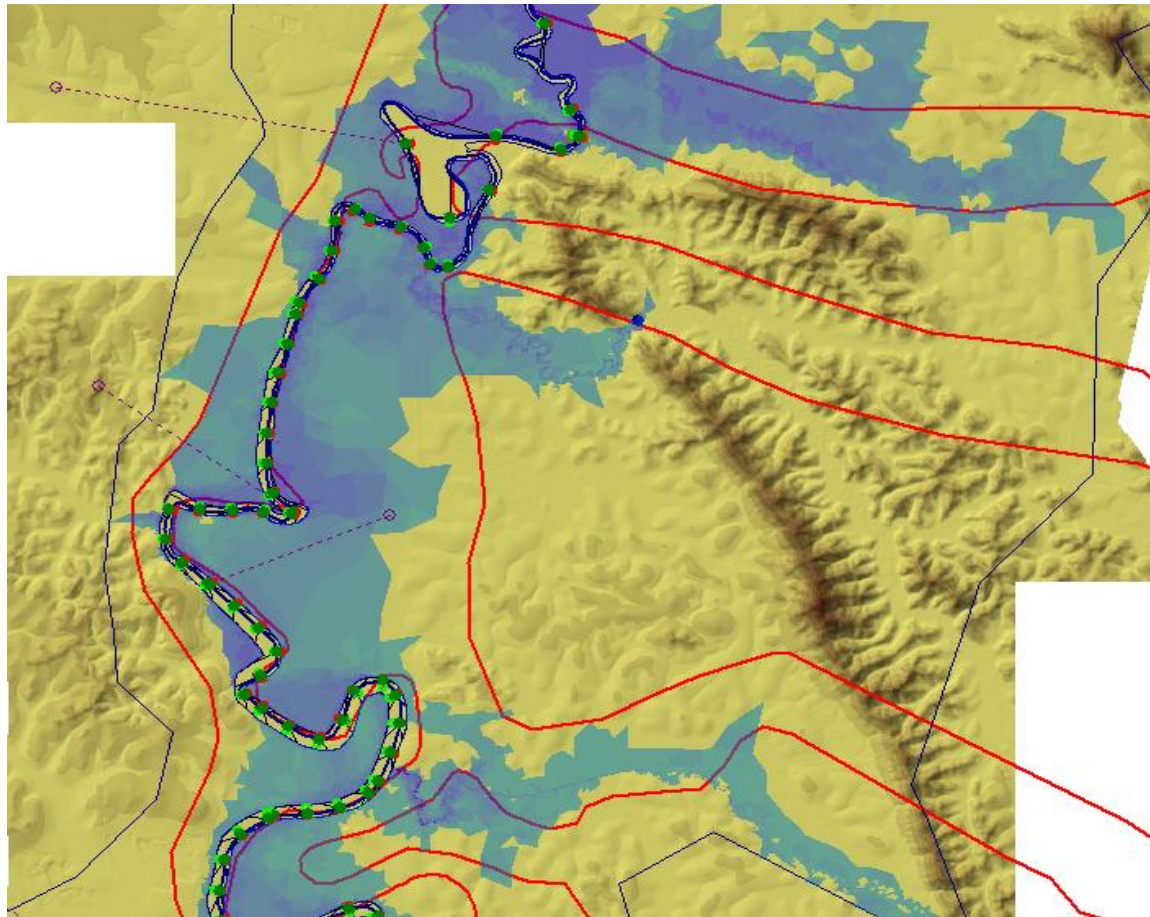


InfoWorks RS [10.5.5] - [GeoPlan - Ruth network_4_1#1 (N-ro) : all 1m [Target]]



Breaklines to
represent higher
ground
(Road/Embankment)

MODEL CALIBRATION



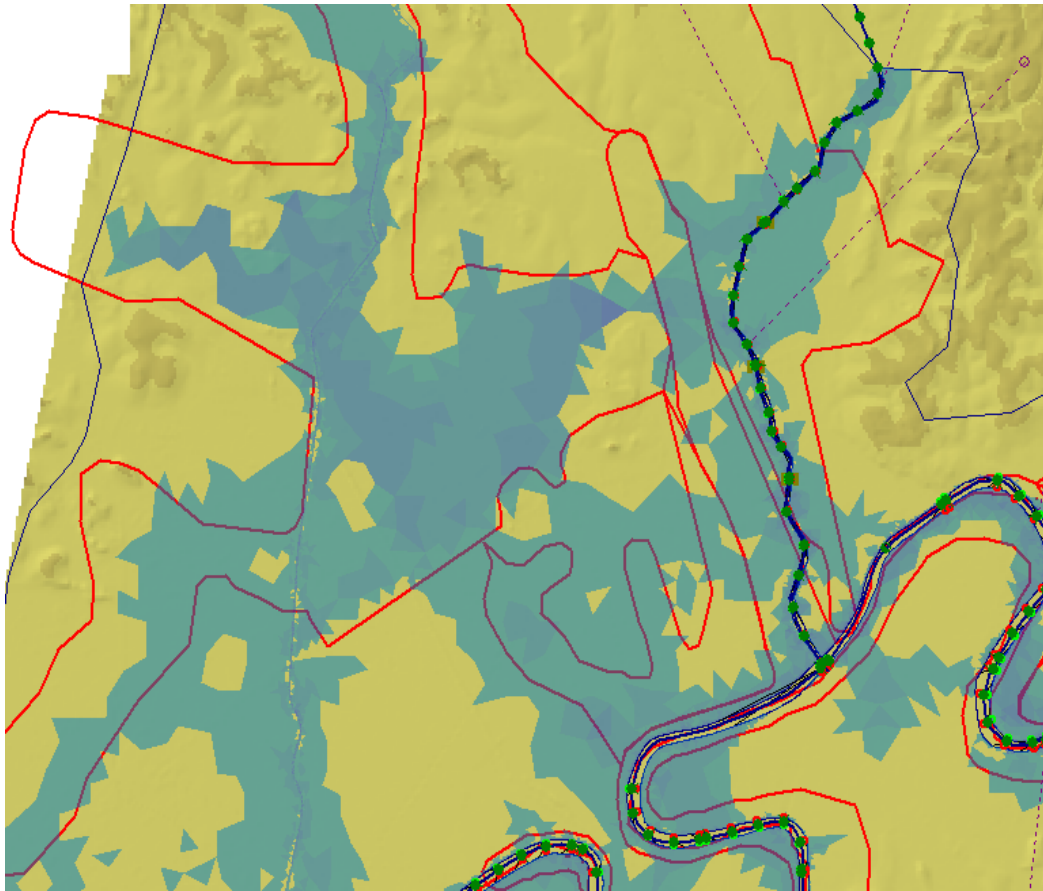
Legend:

Observed
Flood Extend/
Estimation
(DID)

Simulated
Flood Extend

Location 1: 2006 Simulated Flood Map from Ch170 – 180

MODEL CALIBRATION

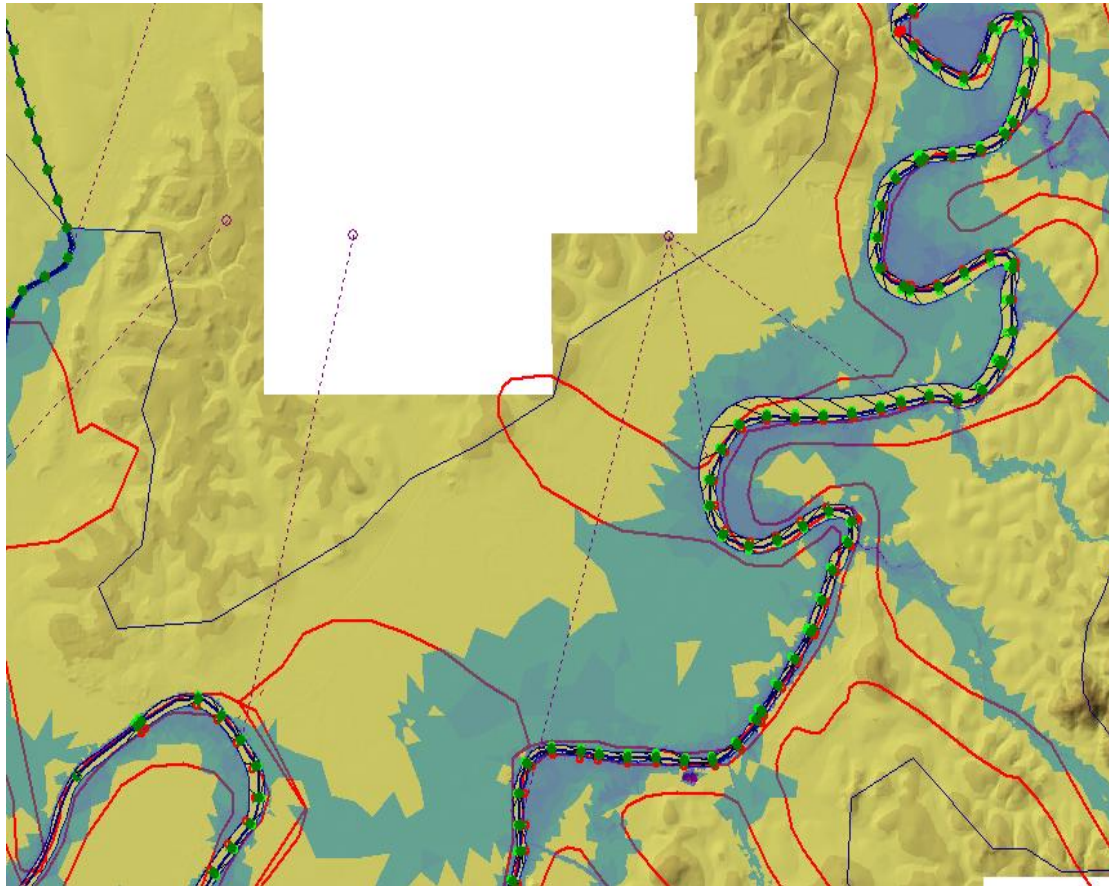


Legend:

- Observed Flood Extend/ Estimation (DID)
- Simulated Flood Extend

Location 2: 2006 Simulated Flood Map from Ch KM180 - 200

MODEL CALIBRATION



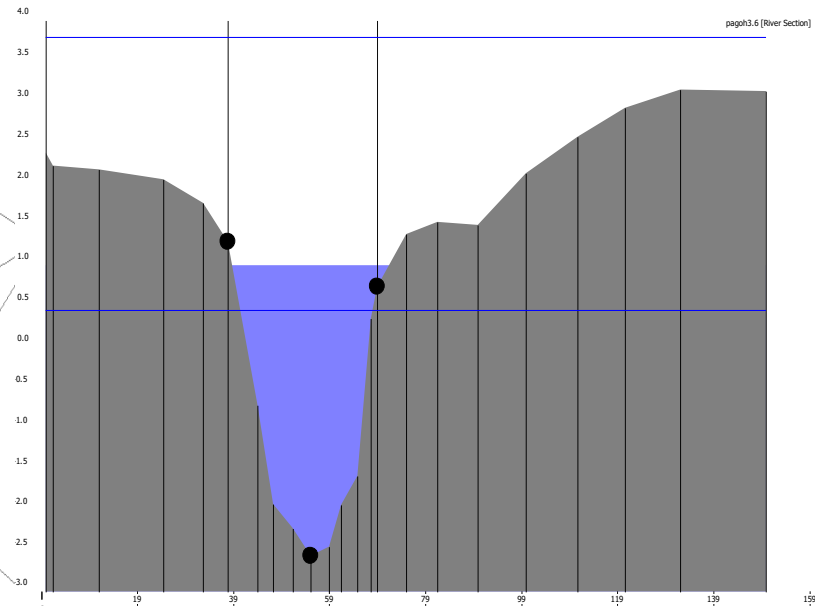
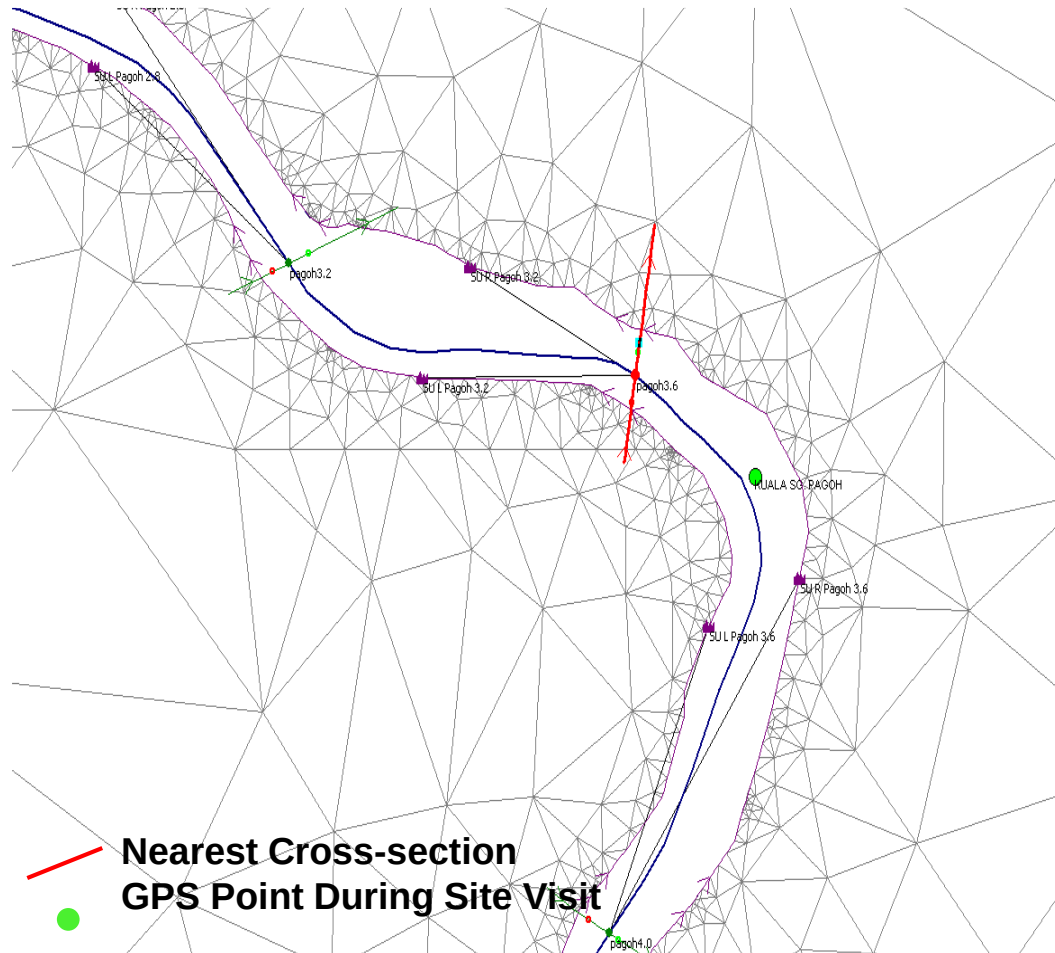
Legend:

-  Observed Flood Extend/ Estimation (DID)
-  Simulated Flood Extend

Location 3: 2006 simulated flood map from Ch KM 253-255

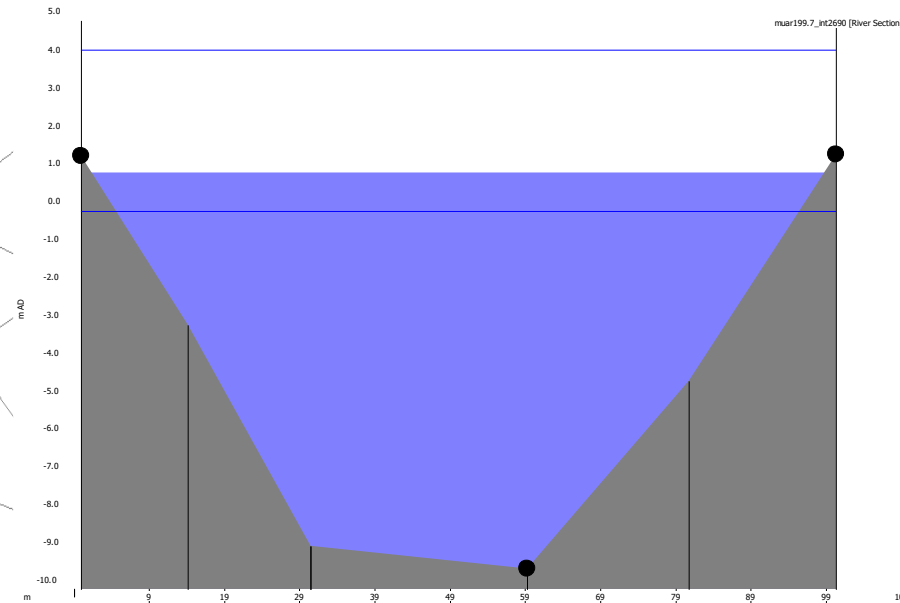
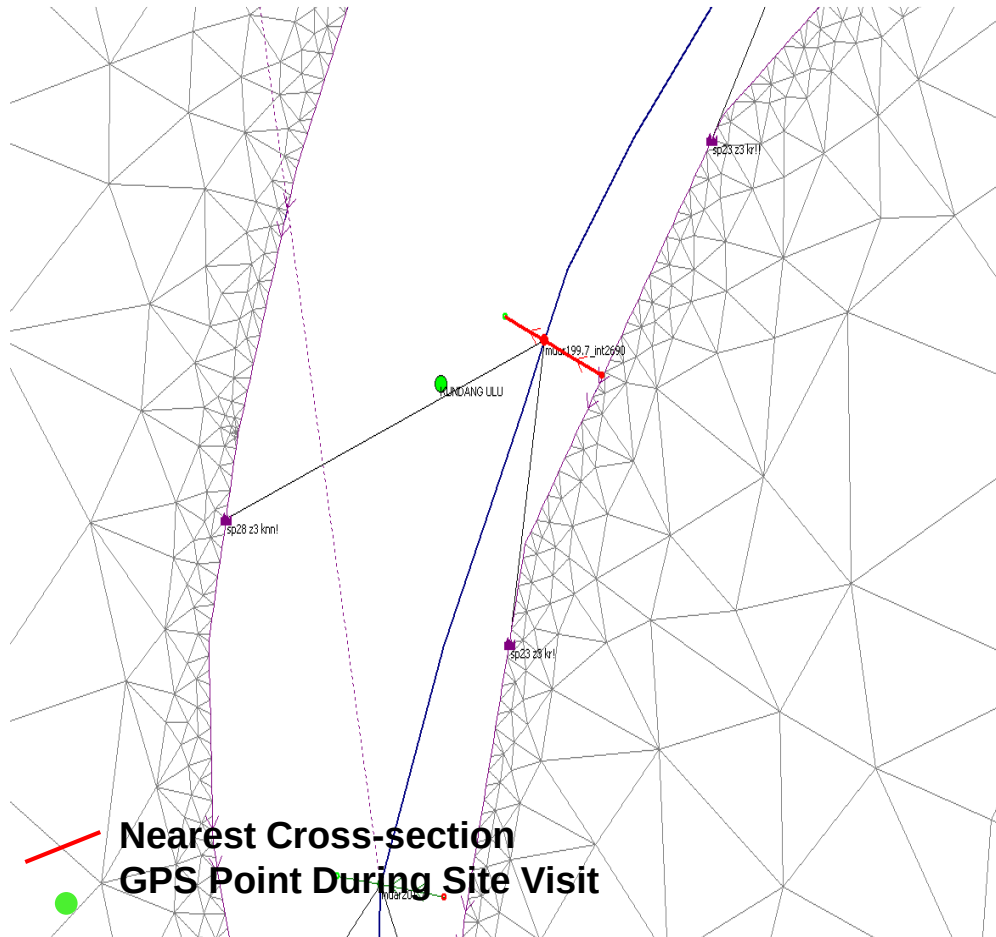
MODEL VERIFICATION

Point 1: Kuala Pagoh (Pagoh 3.6)
Maximum Water Level: 1.5 meter



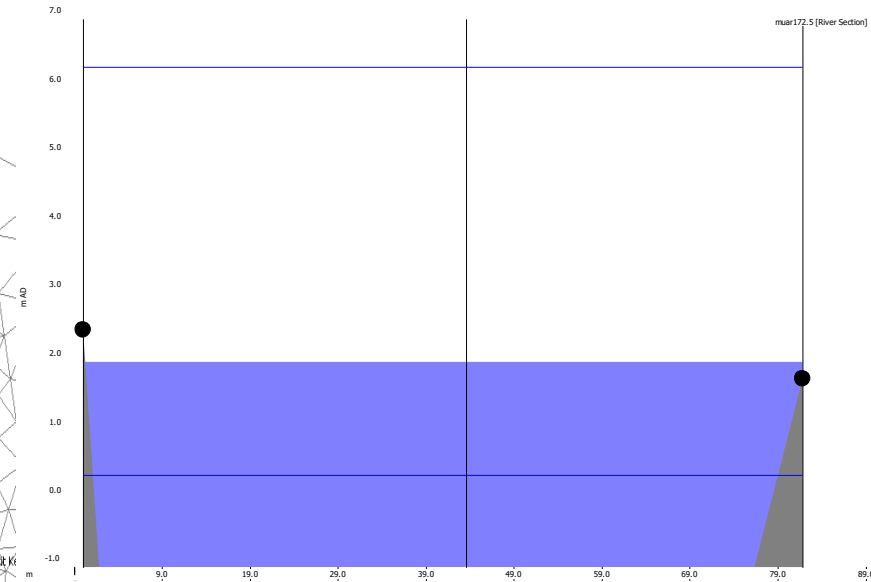
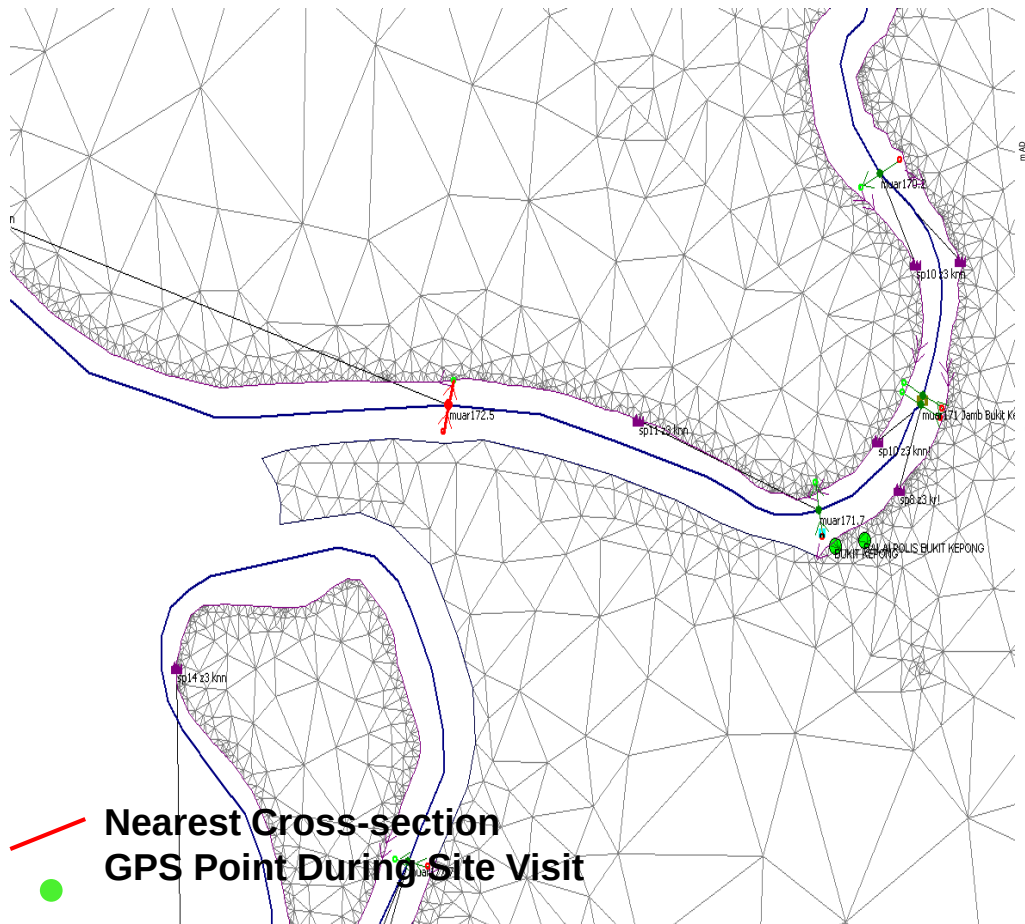
MODEL VERIFICATION

Point 2: Kg Kundang Ulu (muar199.7 int2690)
Maximum Water Level: 3 meter



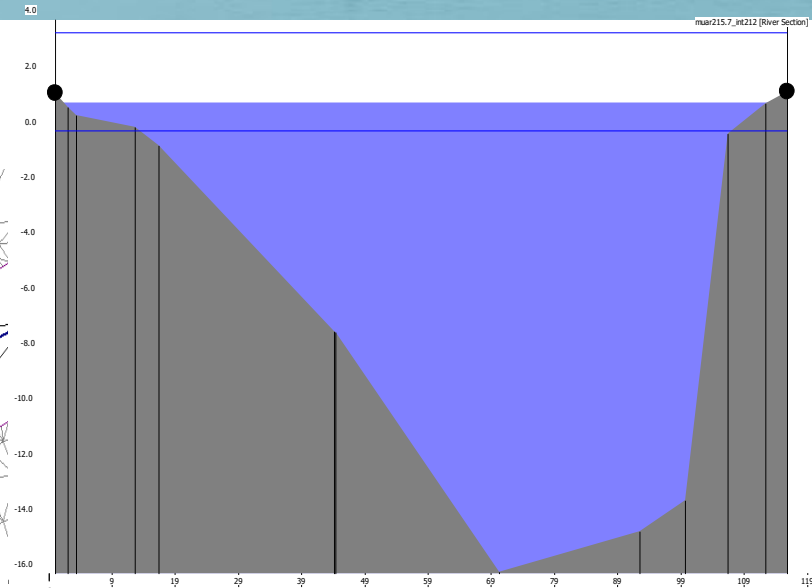
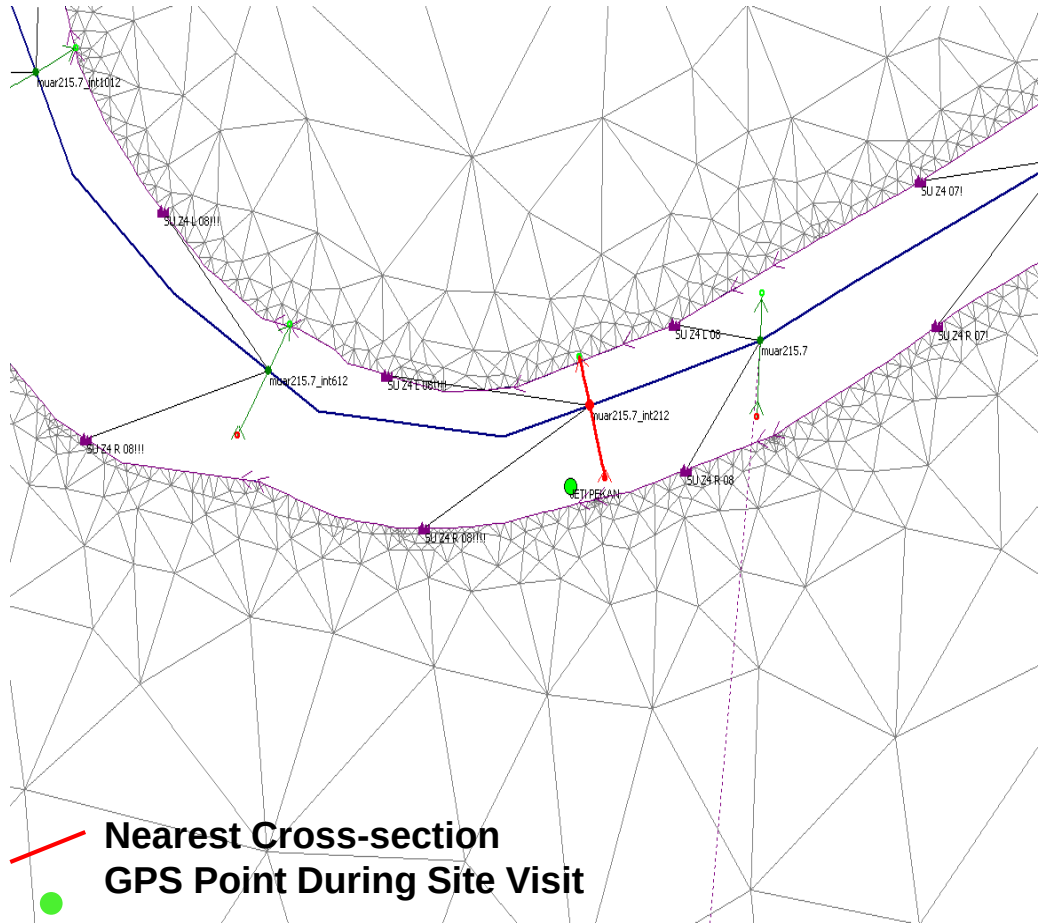
MODEL VERIFICATION

Point 3: Sungai Muar at Bukit Kepong (muar172.5)
Maximum Water Level: 3.5 meter



MODEL VERIFICATION

Point 4: Jeti Pekan Panchor (muar215.7_int212)
Maximum Water Level: 2 meter



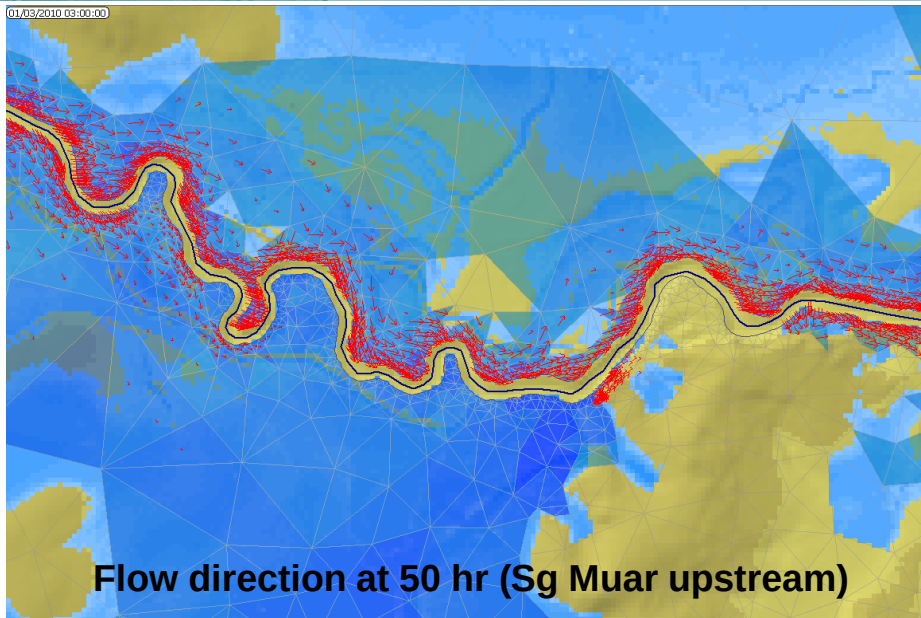
MODEL SIMULATION

LINK TO MODEL SIMULATION

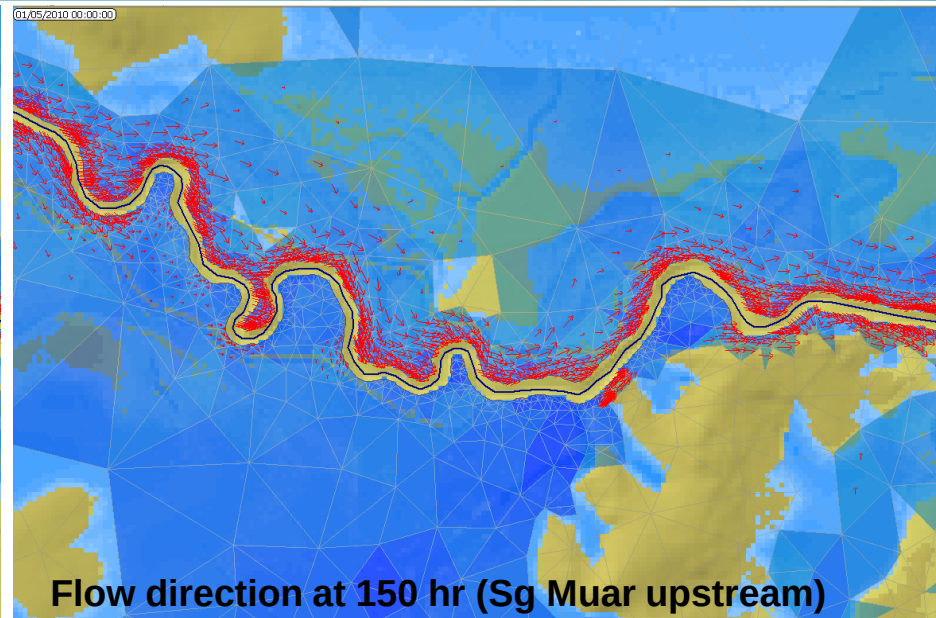


SIMULATION RESULTS

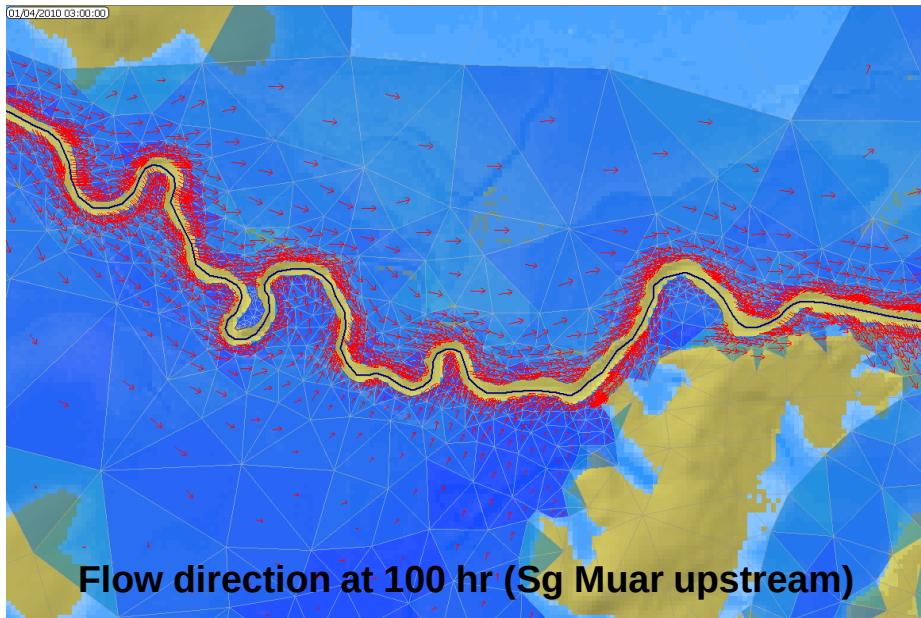
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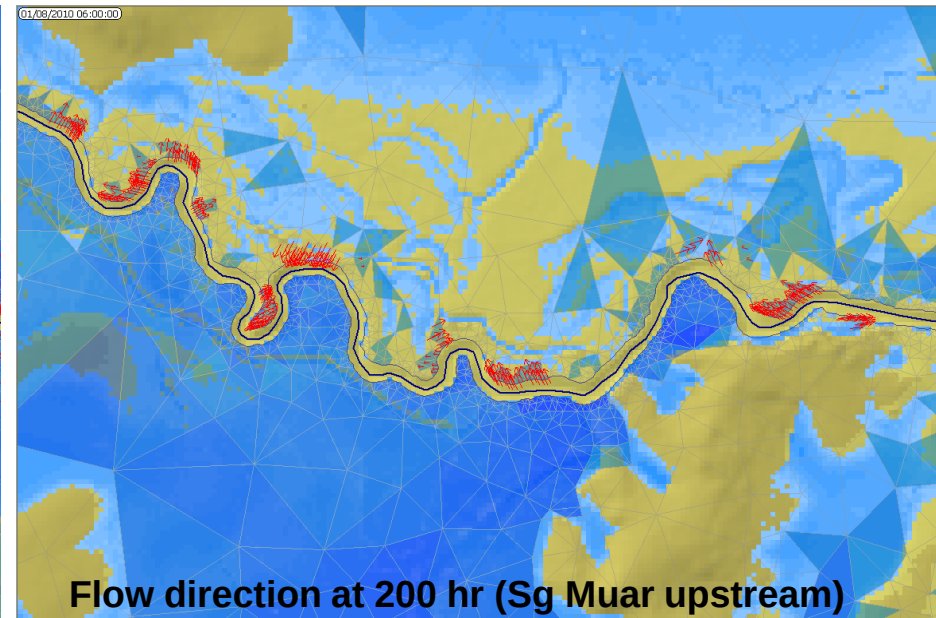
01/05/2010 00:00:00



01/04/2010 03:00:00

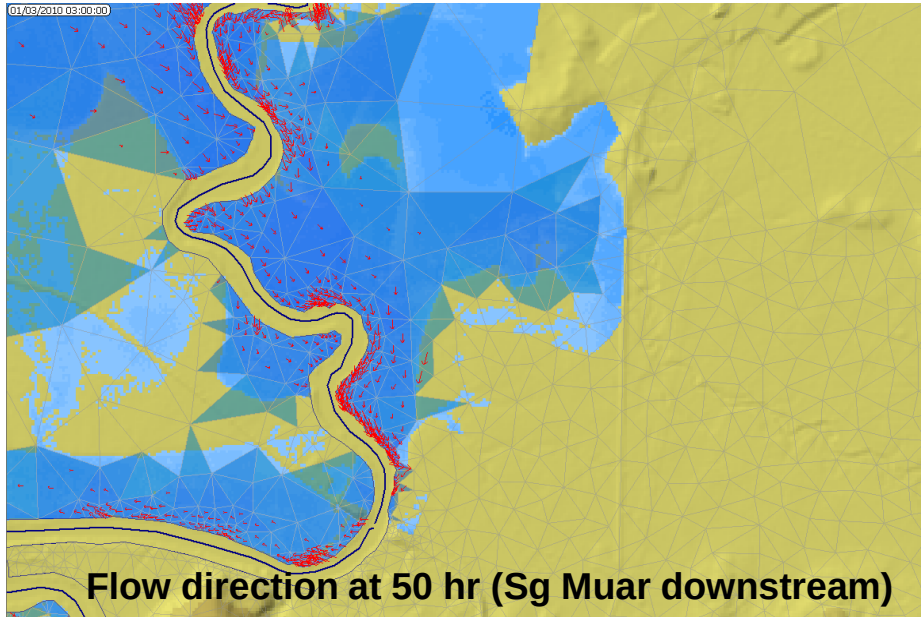


01/06/2010 06:00:00

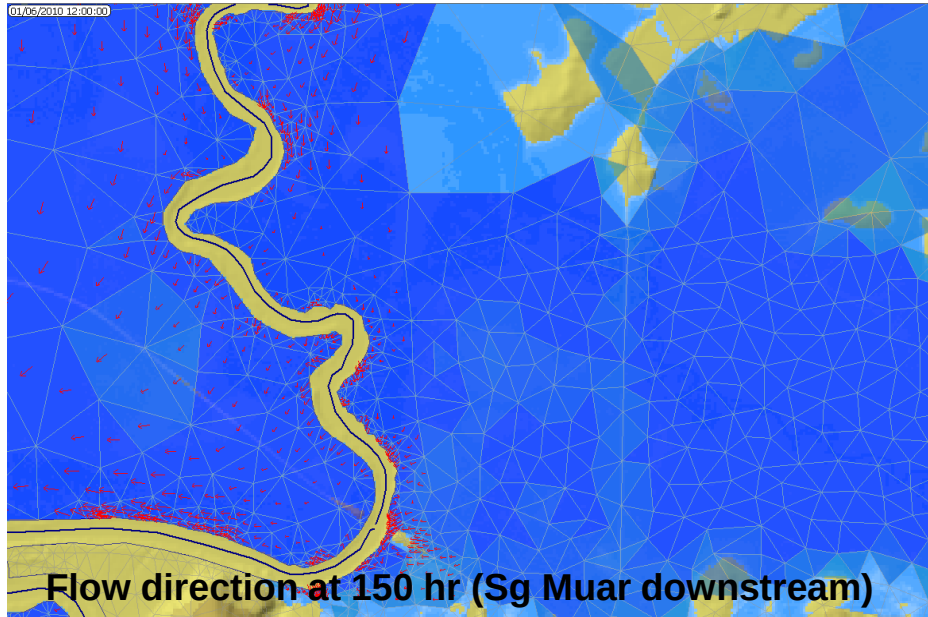


SIMULATION RESULTS

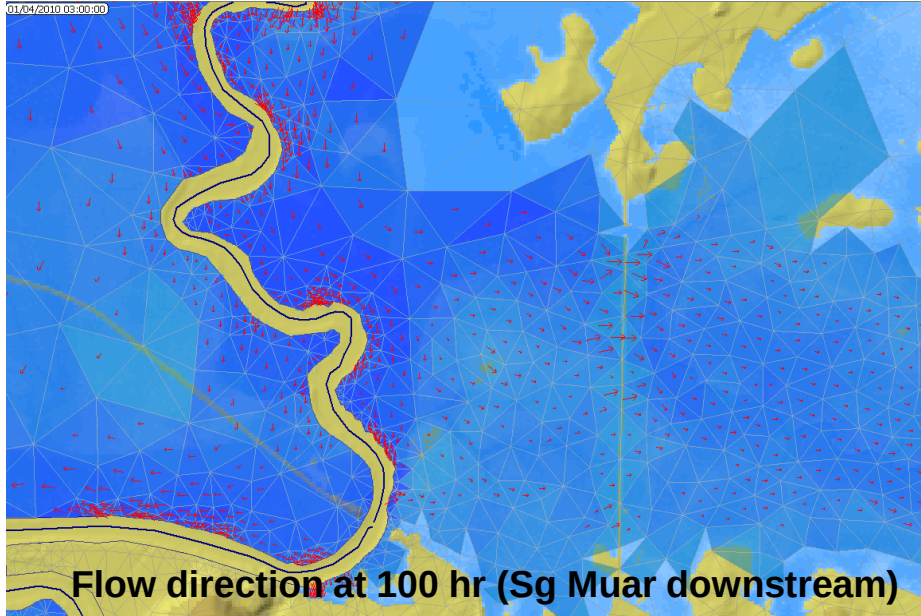
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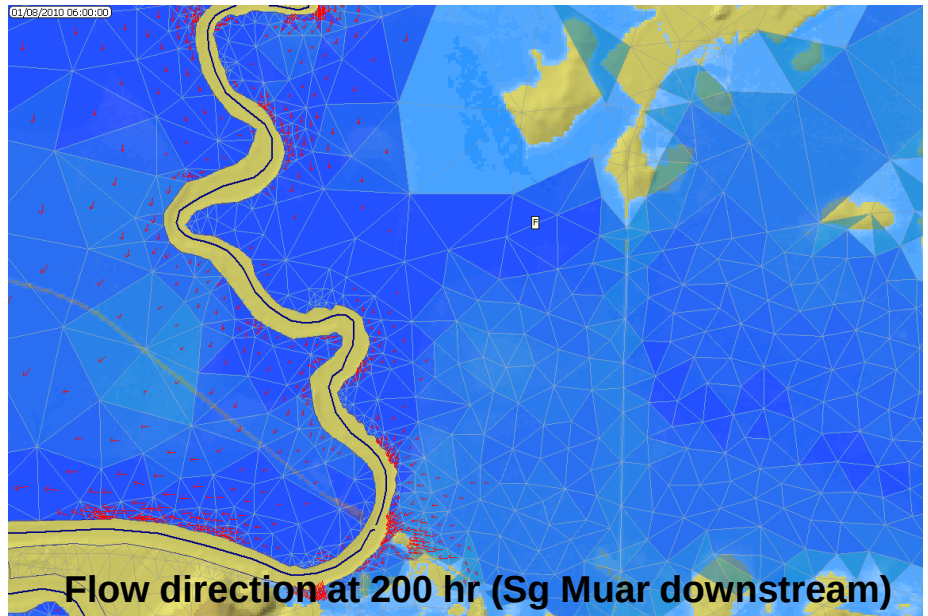
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01/04/2010 03:00:00

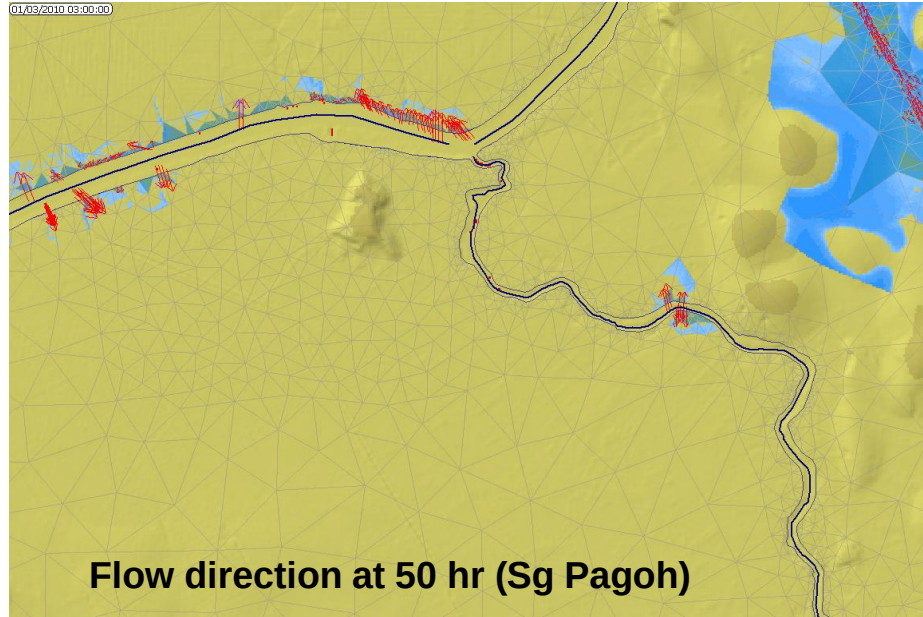


01/08/2010 06:00:00



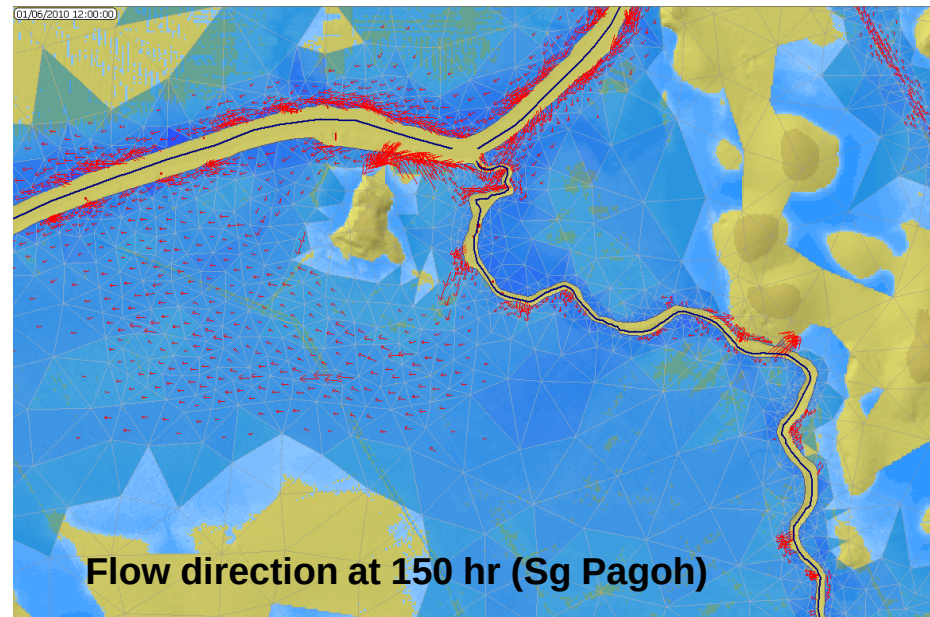
SIMULATION RESULTS

01/03/2010 03:00:00



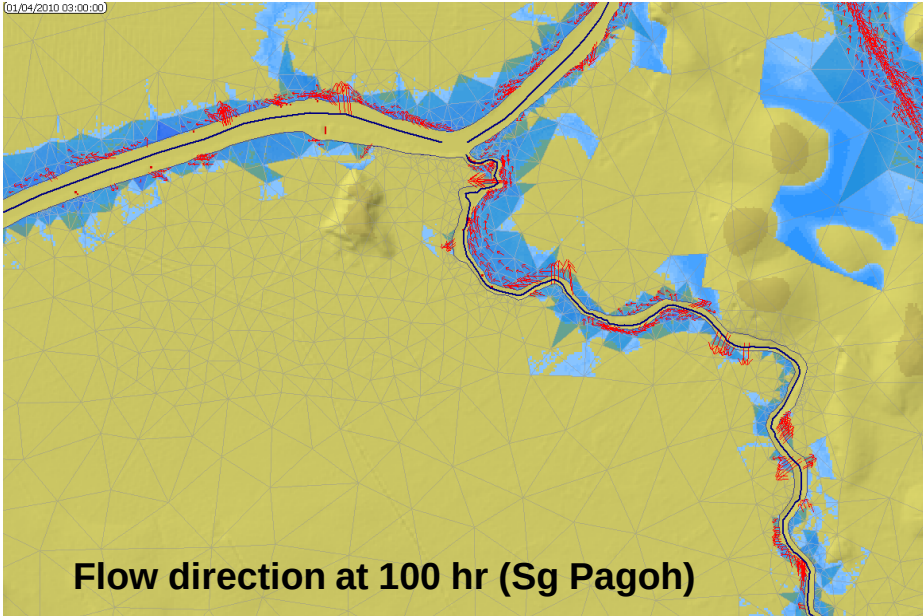
Flow direction at 50 hr (Sg Pagoh)

01/06/2010 12:00:00



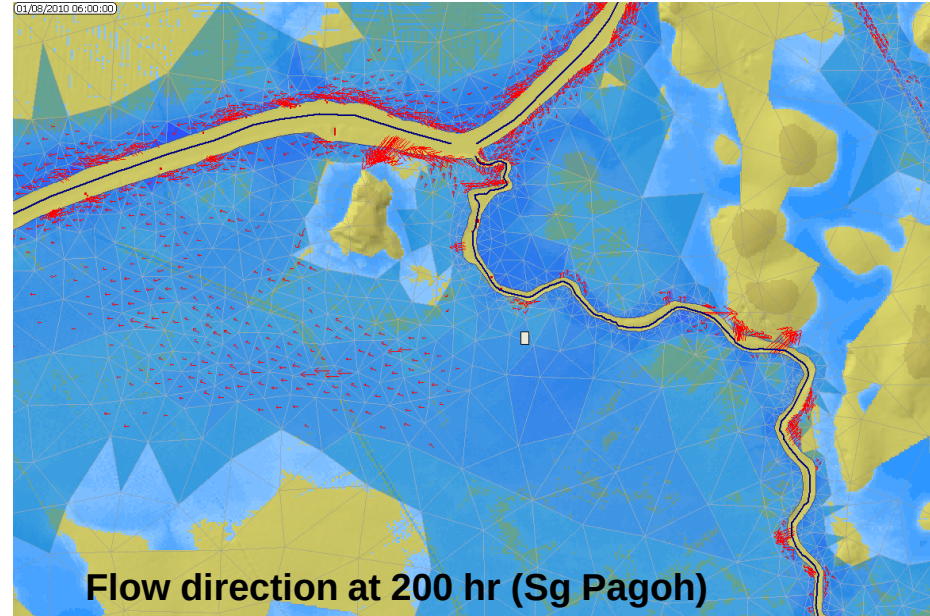
Flow direction at 150 hr (Sg Pagoh)

01/04/2010 03:00:00



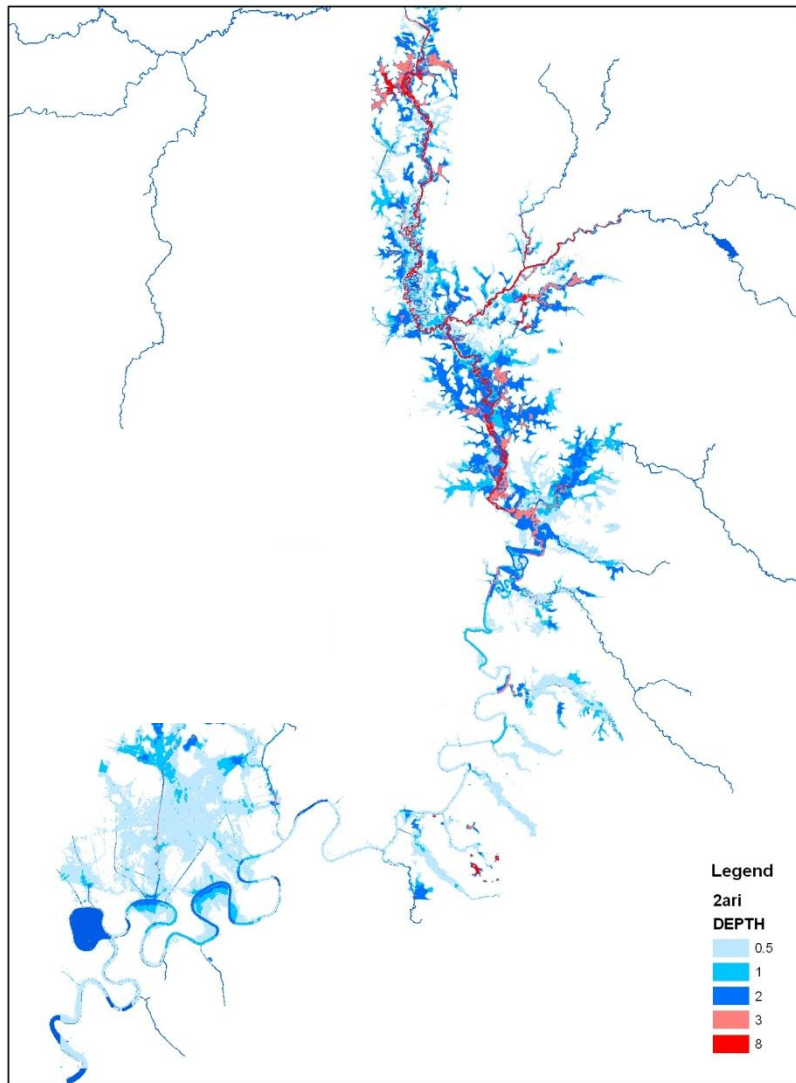
Flow direction at 100 hr (Sg Pagoh)

01/06/2010 06:00:00

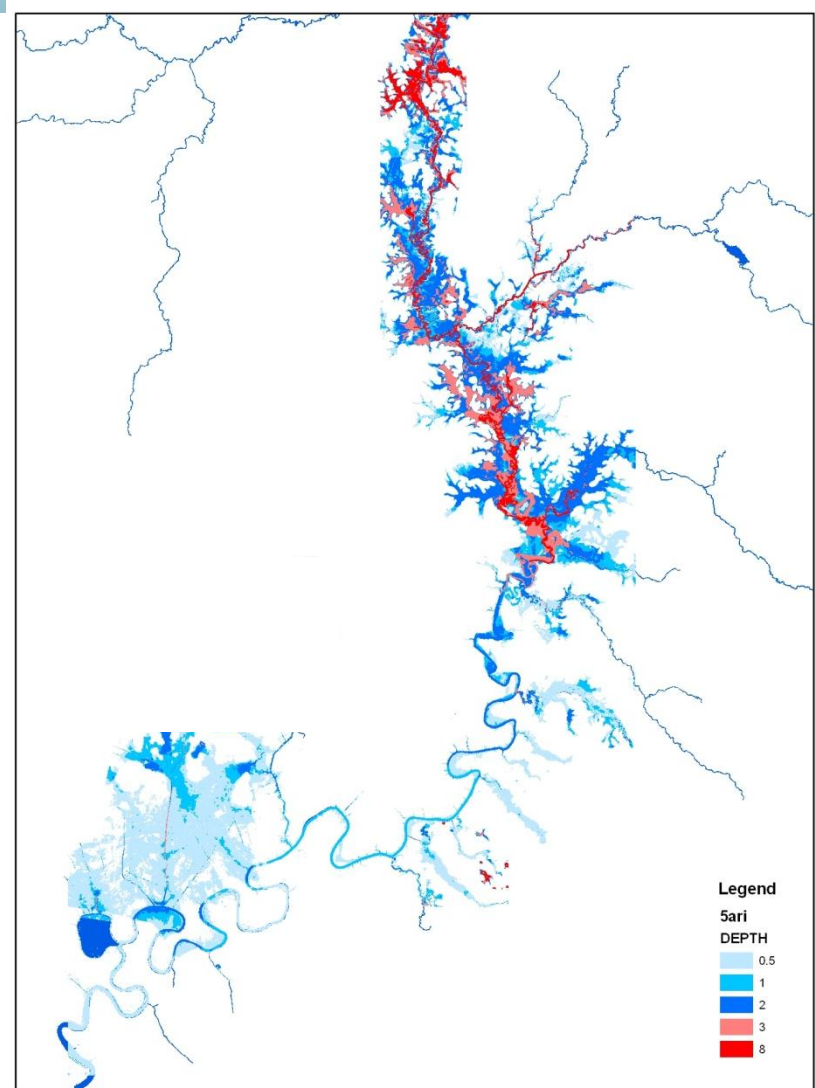


Flow direction at 200 hr (Sg Pagoh)

OUTPUT: FLOOD HAZARD MAPS

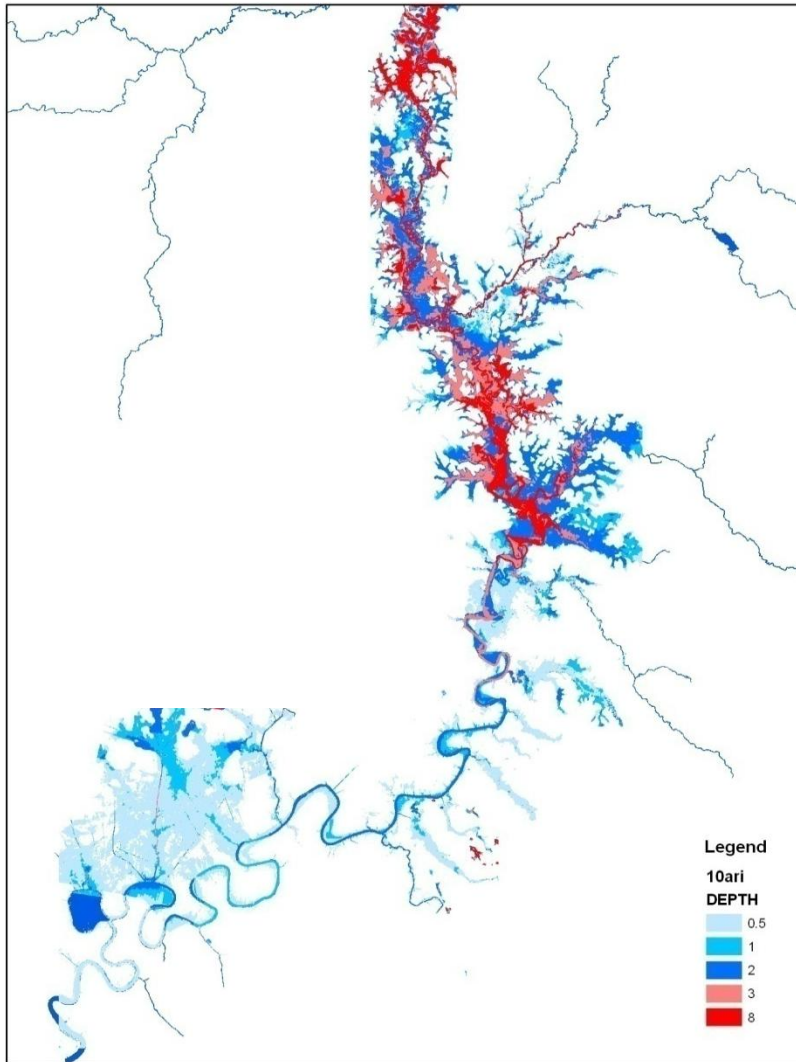


Flood depth for the entire river system for 2 ARI

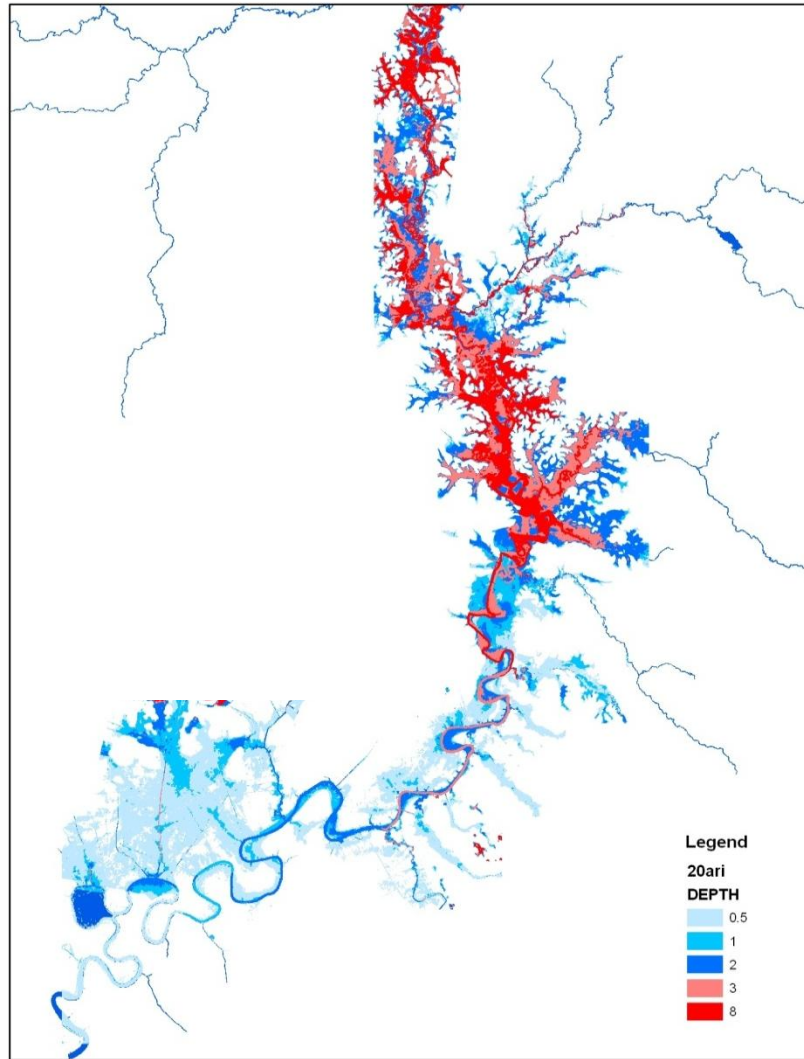


Flood depth for the entire river system for 5 ARI

FLOOD HAZARD MAPS

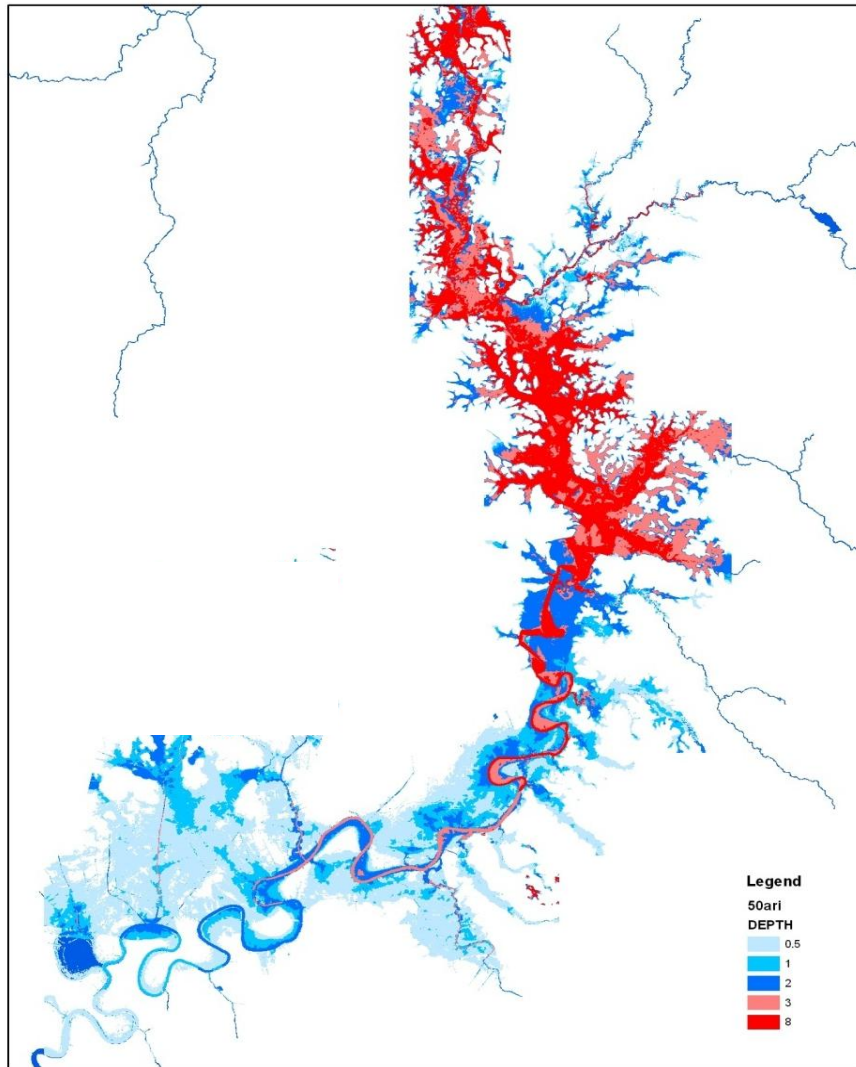


Flood depth for the entire river system for 10 ARI

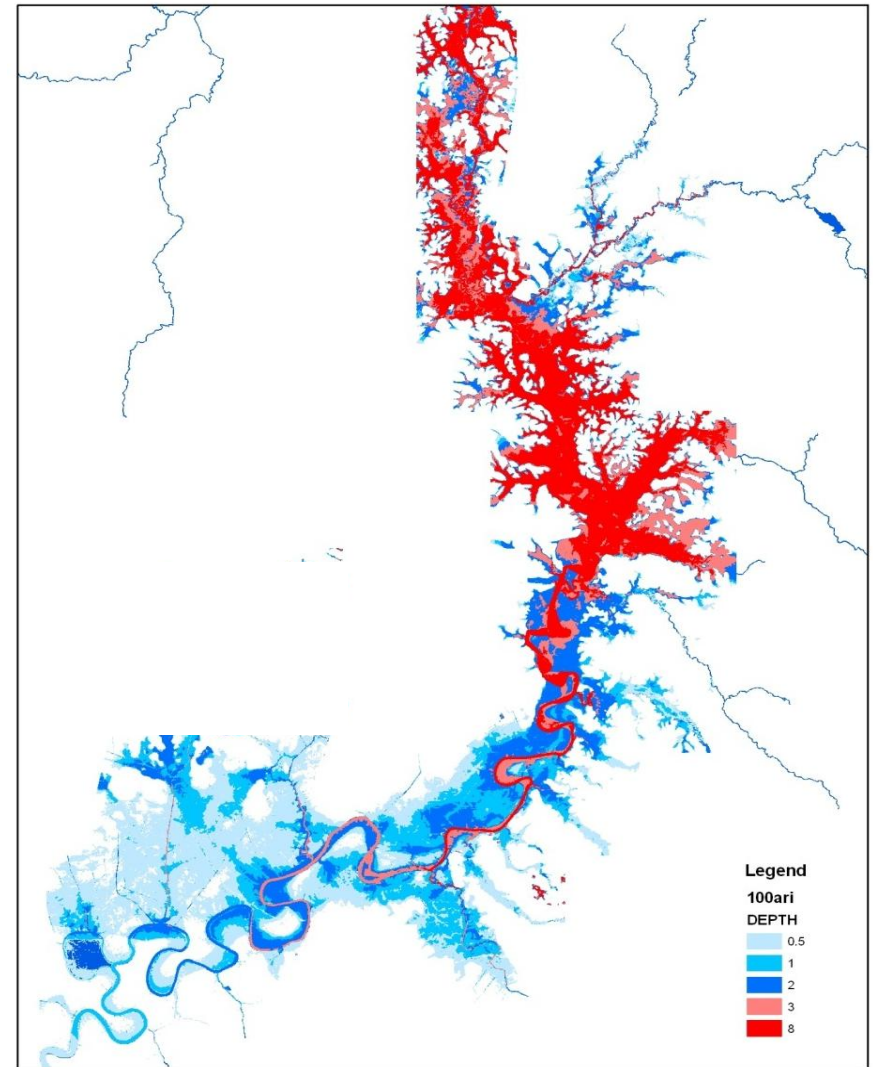


Flood depth for the entire river system for 20 ARI

FLOOD HAZARD MAPS



Flood depth for the entire river system for 50 ARI



Flood depth for the entire river system for 100 ARI

CONCLUSION

- 2D hydrodynamic modeling >> useful in developing a better quality of flood maps based on available LiDAR informations
- Can be used for future flood mapping delineation
- A total of 300,000 meshes of simulation polygon were created for 2-D model >> Time consuming compared to 1-D Model
- Flood maps content depth and velocity >> Could be used for the purpose of flood risk analysis
- Engineers or planners can refer to flood maps >> To determine the platform level for various return periods and future landuse planning in a new development project to minimise flooding risk.
- Local authority and community >> To prioritise flood preparedness, mitigation and control activities.



THANK YOU



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