The impact of land use and land cover change on river morphology

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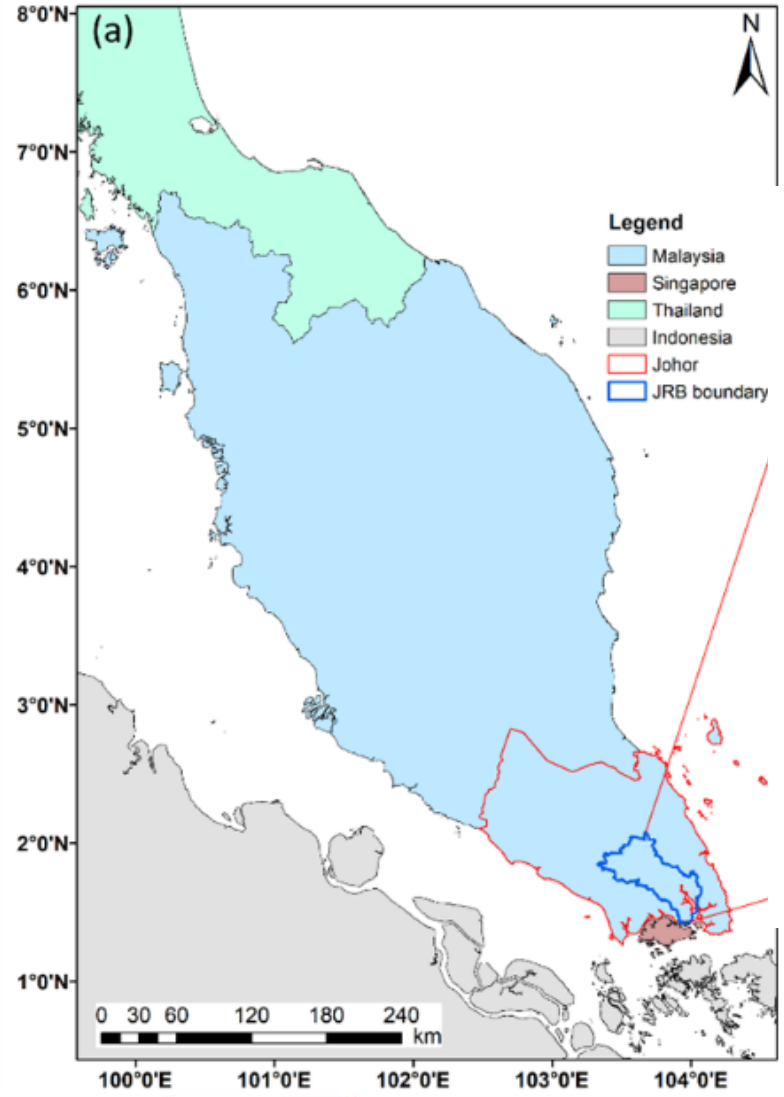
Project overview

- Funded by Universiti Teknologi Malaysia
- Land use change and its impact on Johor river morphology and river basin ecosystem services

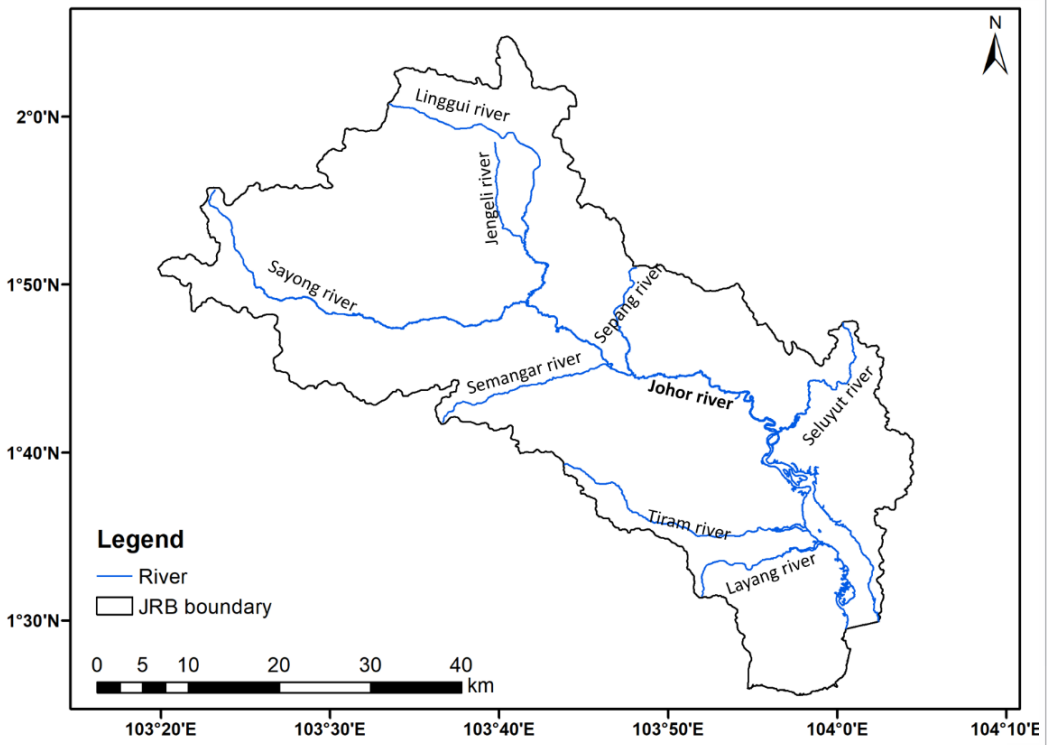
1) Classify different land uses and detect their changes between 1990 to 2020 using remote sensing imageries
2) Assess the impact of land use change on the morphology (length, width, extent and shape) of Johor River
3) Evaluate the impact of land use changes of ecosystem services (carbon storage, water yield and sediment retention) and
4) Valuate the economic values of the ecosystem services.

Johor River Basin



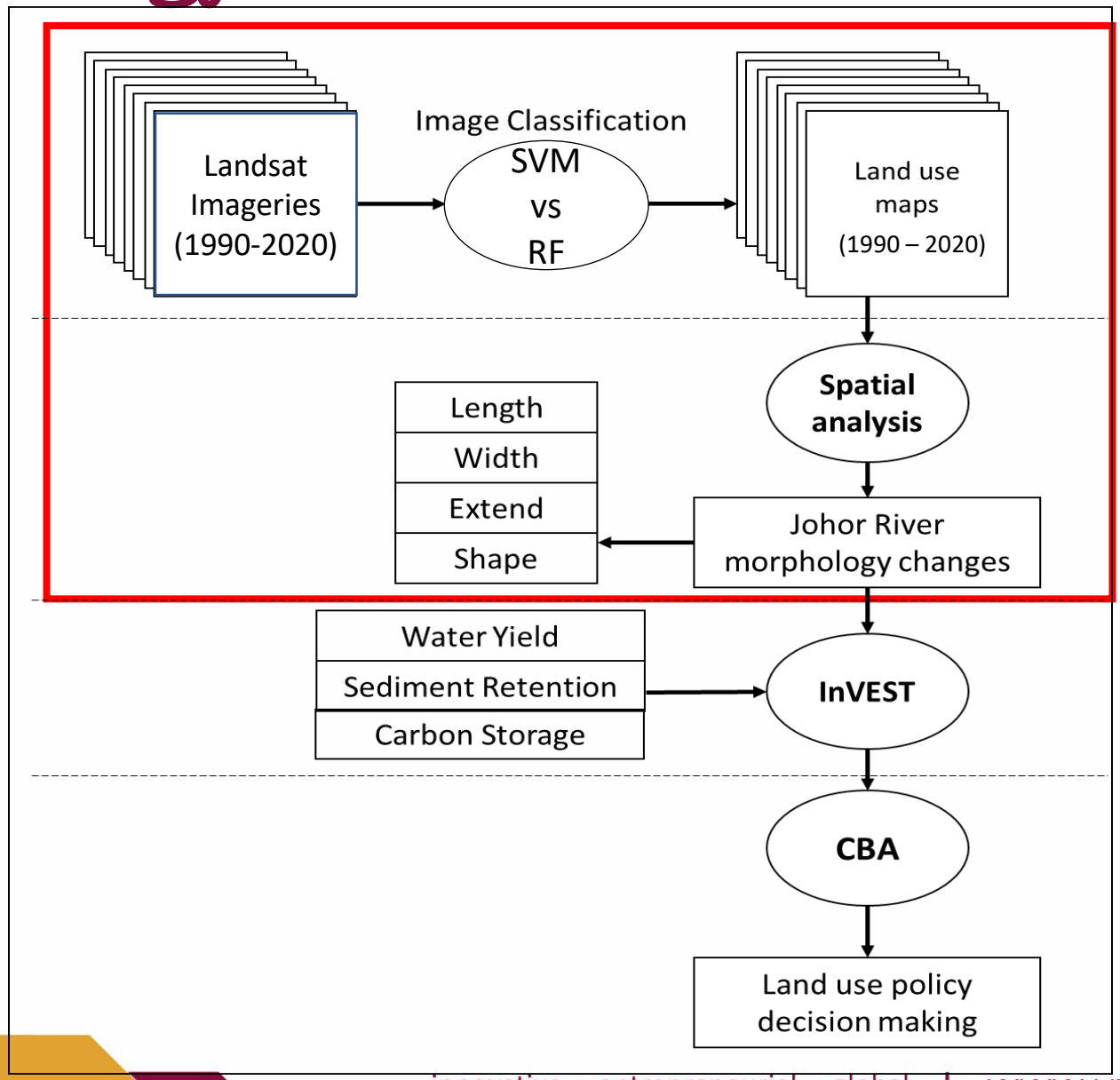
Covers 2,386 KM^2

122 km long



Johor River Basin

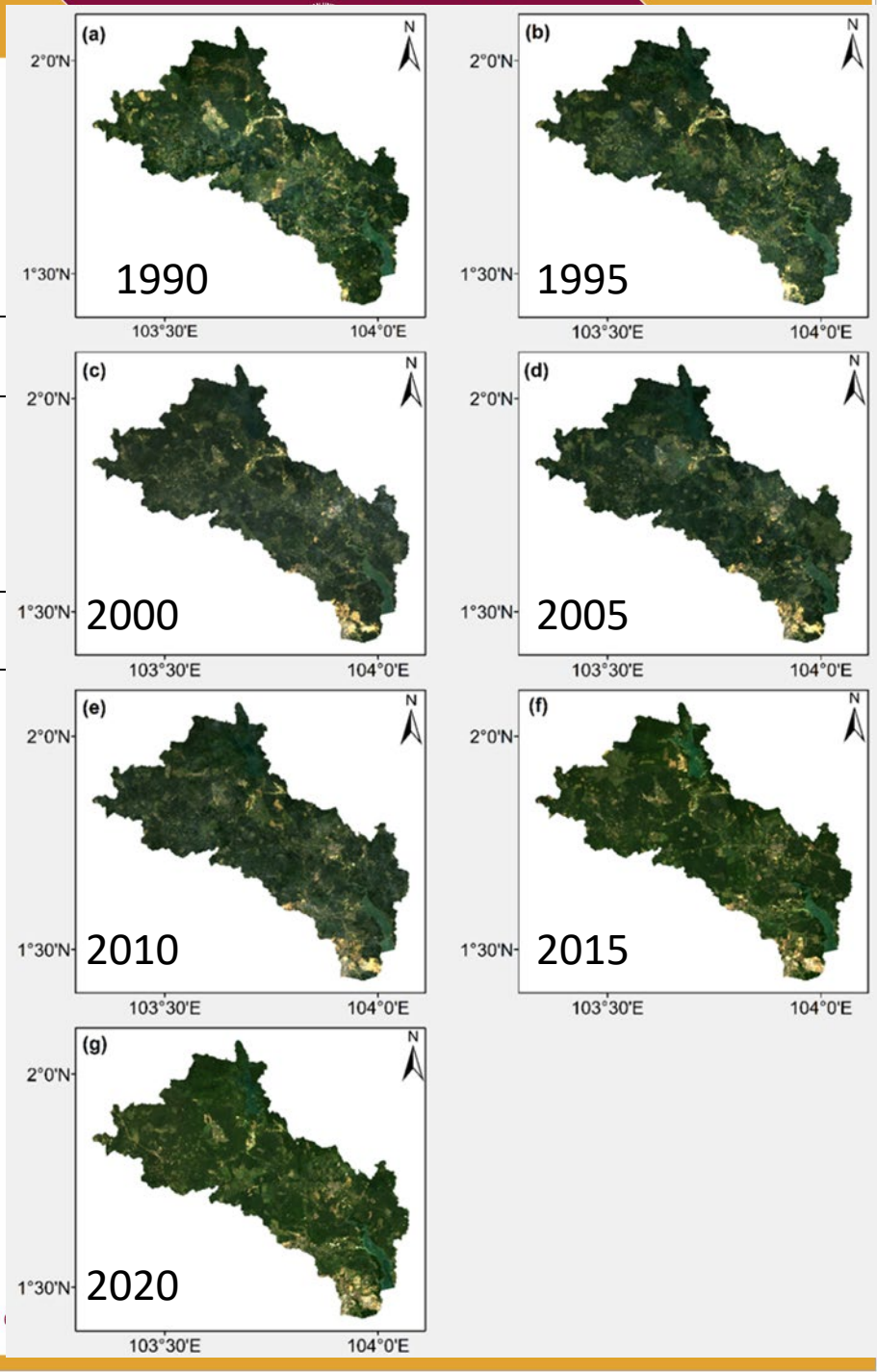
Methodology



Cloudless Landsat Data

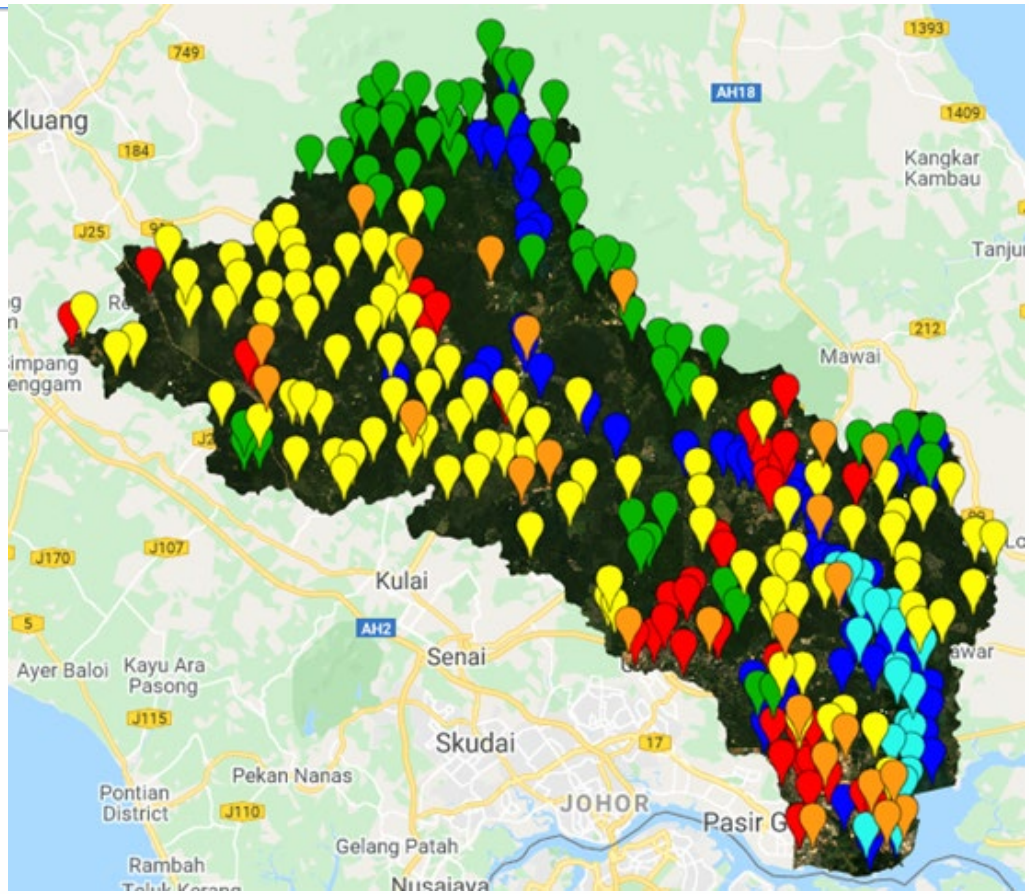
Satellite	Year	Timeframe		n
		Start	End	
Landsat-5	1990	1989/06/01	1990/12/31	34
	1995	1994/06/01	1996/05/31	76
	2000	1999/06/01	2001/05/31	78
	2005	2004/01/01	2005/12/31	87
	2010	2009/01/01	2010/12/31	61
Landsat-8	2015	2014/09/01	2015/12/31	67
	2020	2020/01/01	2020/12/31	53

*n = number of scenes compiled.

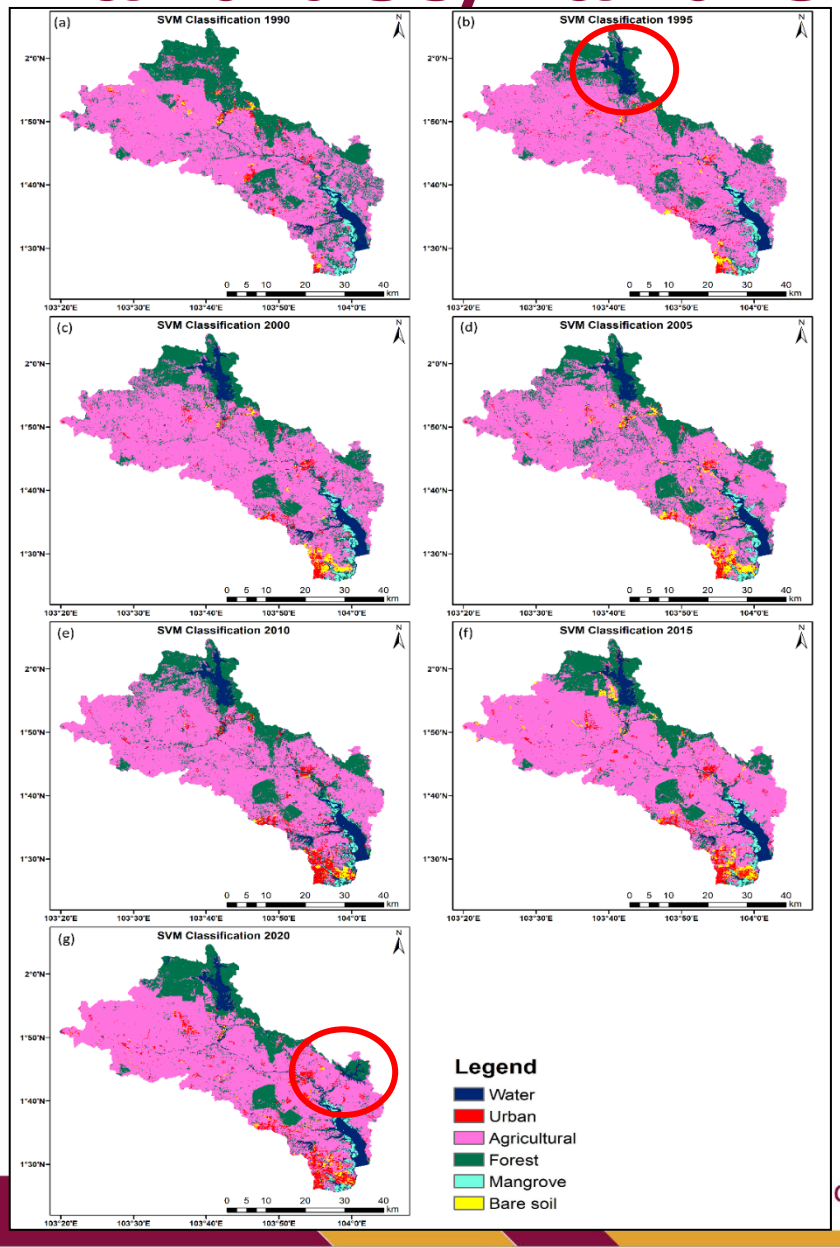


Training and Validation samples

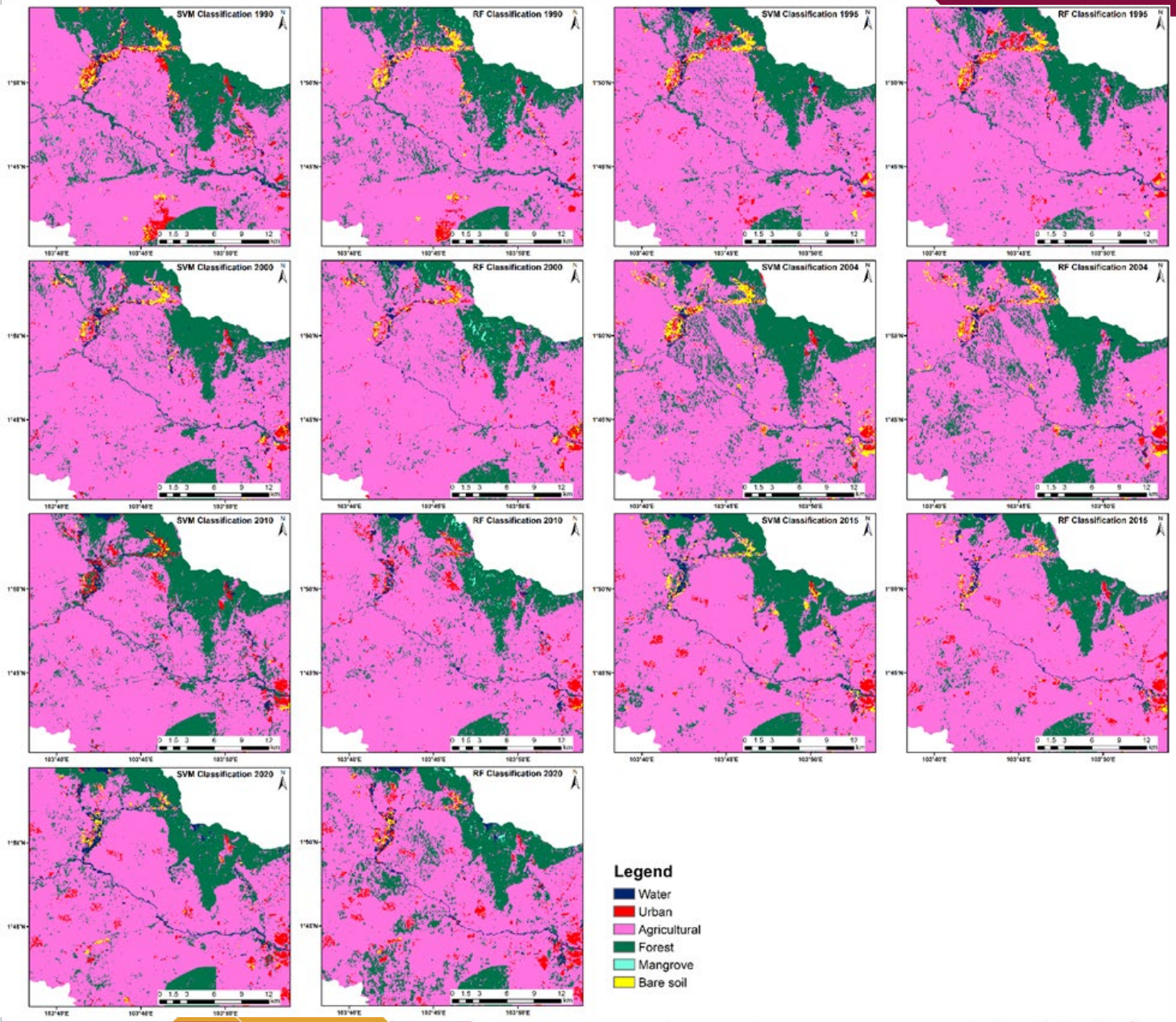
```
Imports (7 entries)
  var Water: FeatureCollection (60 elements)
    type: FeatureCollection
    columns: Object (2 properties)
    features: List (60 elements)
  var Urban: FeatureCollection (40 elements)
  var Mangrove: FeatureCollection (20 elements)
  var Forest: FeatureCollection (55 elements)
  var Oilpalm: FeatureCollection (100 elements)
  var Bareland: FeatureCollection (25 elements)
```

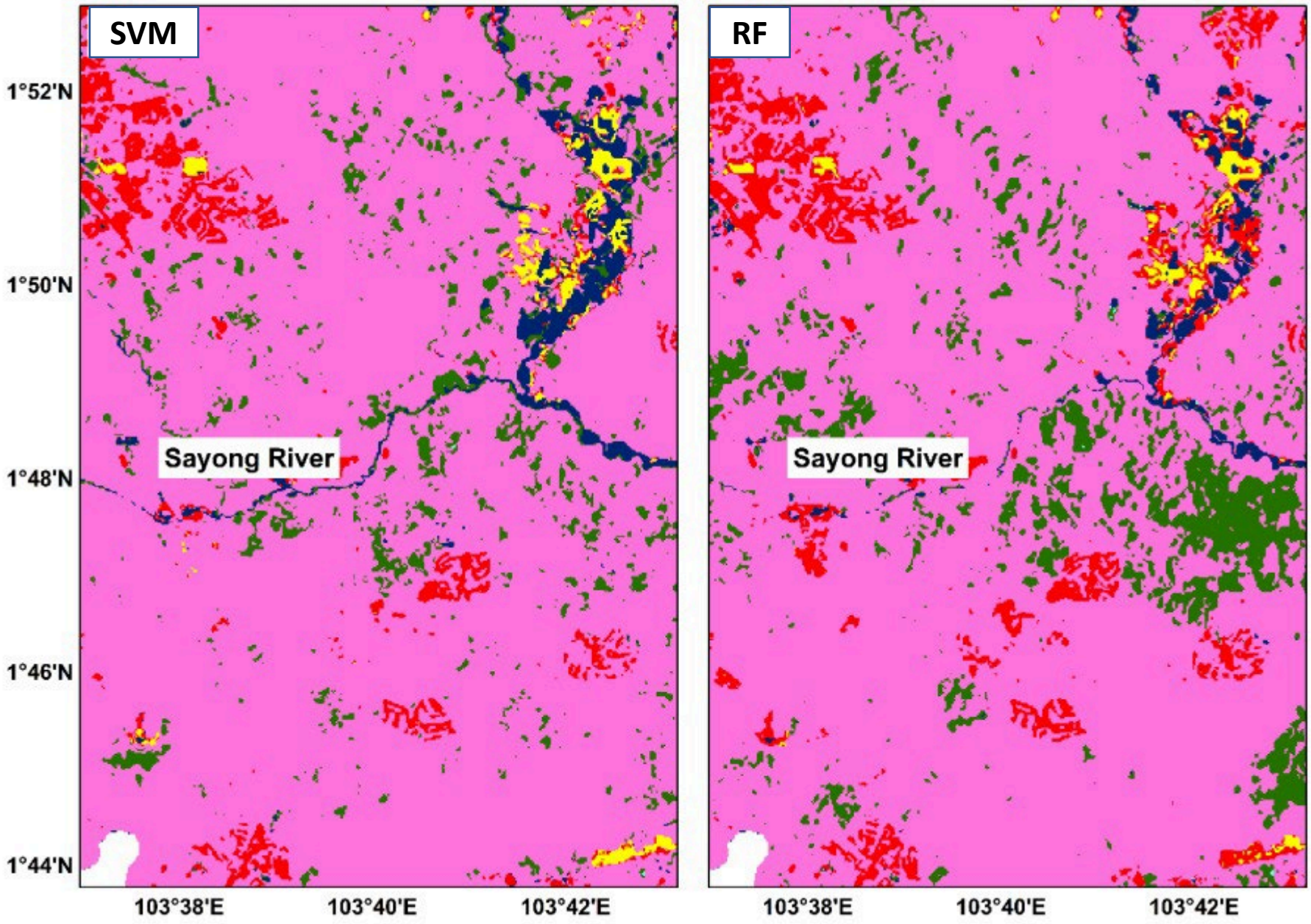


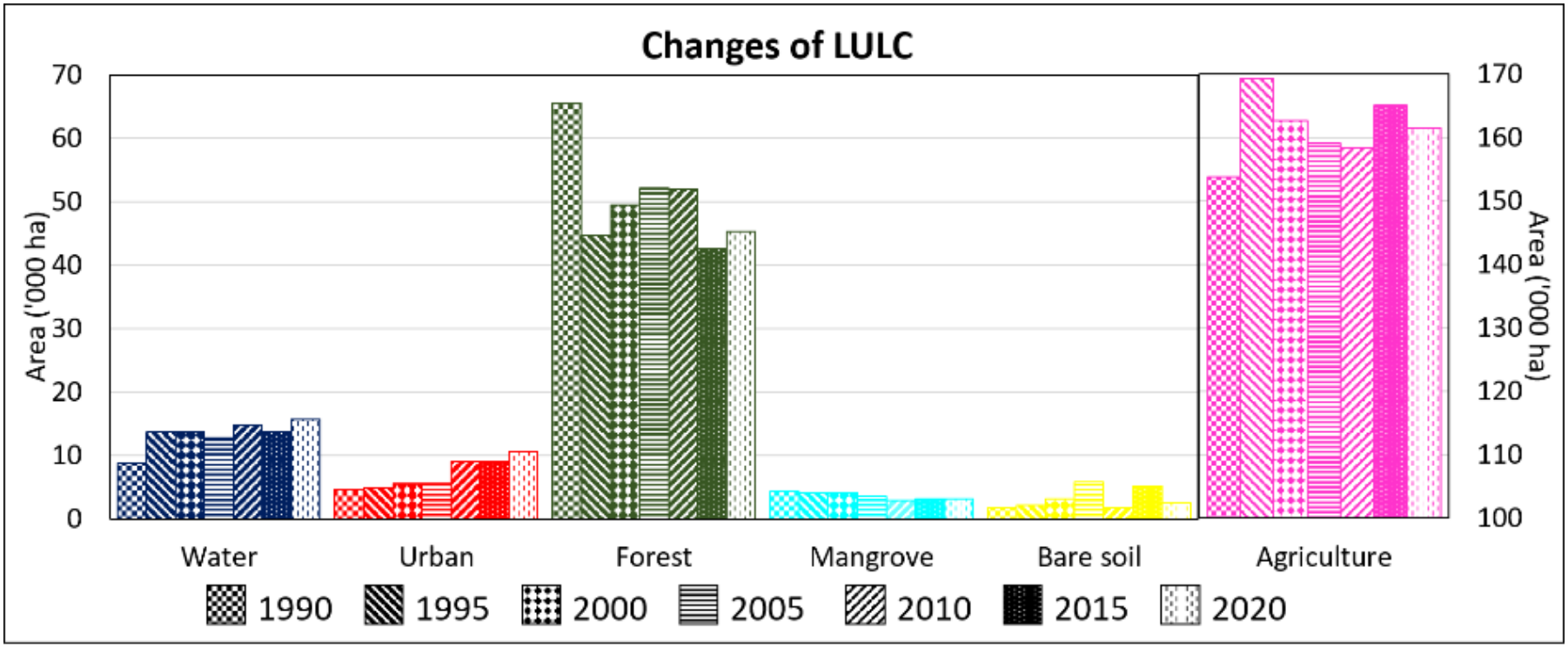
Land use/Land Cover Classification



- More than 90% overall accuracy
- SVM showed better capability to identify river lines

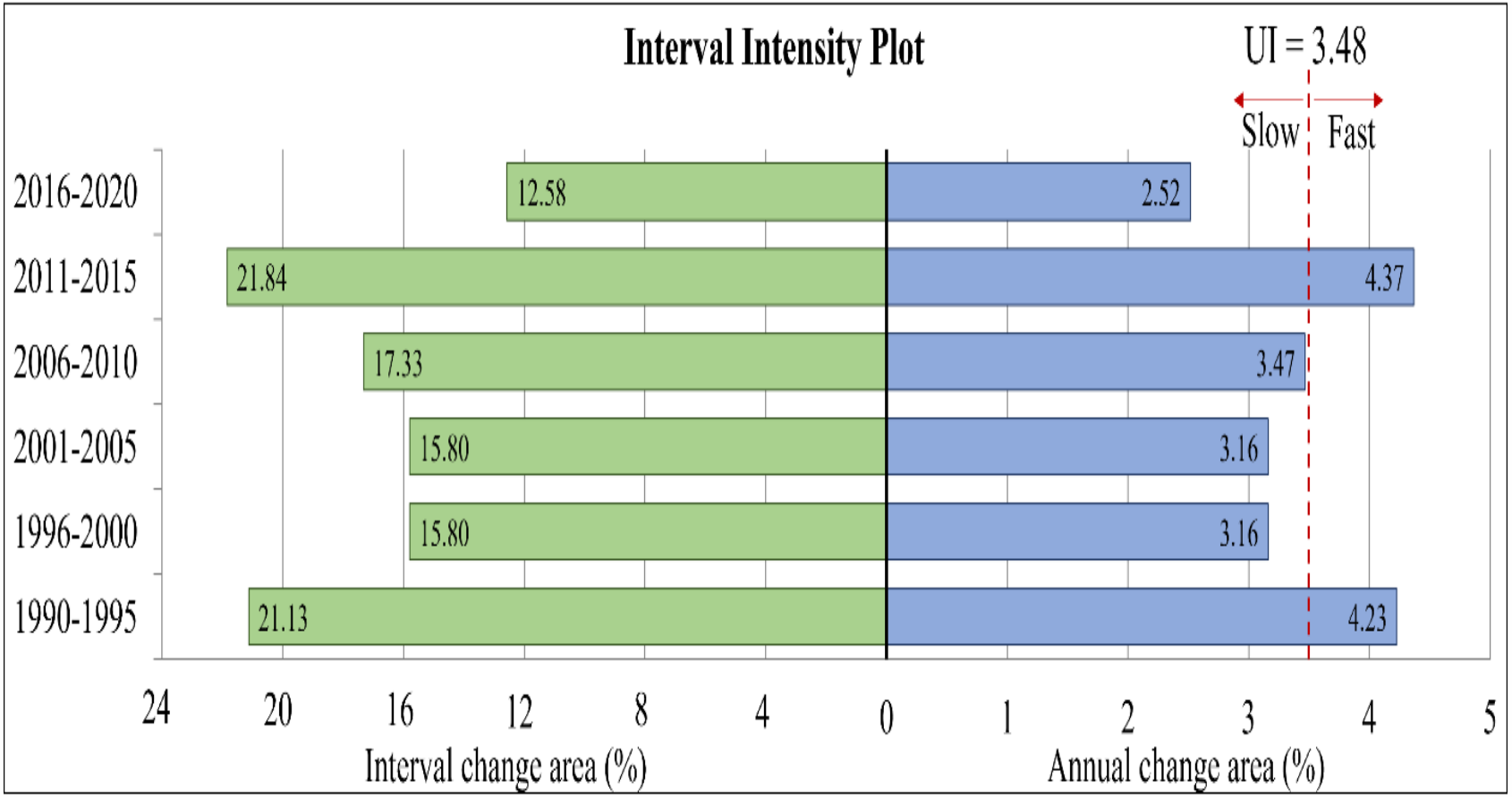

SVM Classification 1990
RF Classification 1990
SVM Classification 1995
RF Classification 1995
SVM Classification 2000
RF Classification 2000
SVM Classification 2004
RF Classification 2004
SVM Classification 2010
RF Classification 2010
SVM Classification 2015
RF Classification 2015
SVM Classification 2020
RF Classification 2020
Legend
Water
Urban
Agricultural
Forest
Mangrove
Bare soil


SVM
RF
Sayong River
Sayong River
1°52'N
1°50'N
1°48'N
1°46'N
1°44'N
103°38'E
103°40'E
103°42'E
103°38'E
103°40'E
103°42'E



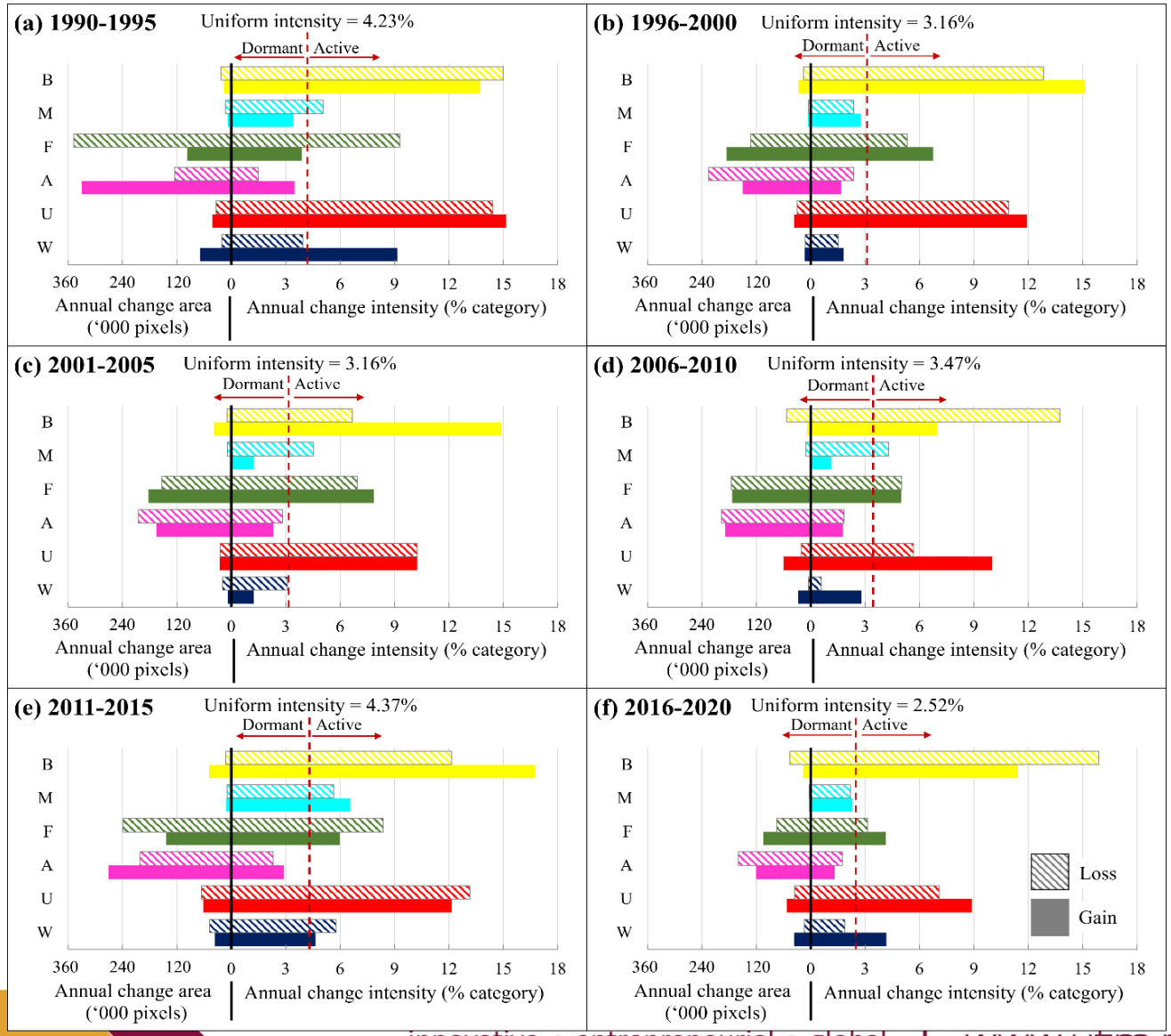
- 46% decrease in forest, mostly between 1990-1995
- 11% increase in agricultural land to support national income
- 30% decrease in mangroves 1990-2020- port construction and oil palm
- 24% increase in water bodies (Dam construction, sand mining)
- 69% increase in urban areas

LULC Change


Interval Intensity Plot
UI = 3.48
Slow
Fast
2016-2020
2011-2015
2006-2010
2001-2005
1996-2000
1990-1995
12.58
2.52
21.84
4.37
17.33
3.47
15.80
3.16
15.80
3.16
21.13
4.23
24
20
16
12
8
4
0
1
2
3
4
5
Interval change area (%)
Annual change area (%)

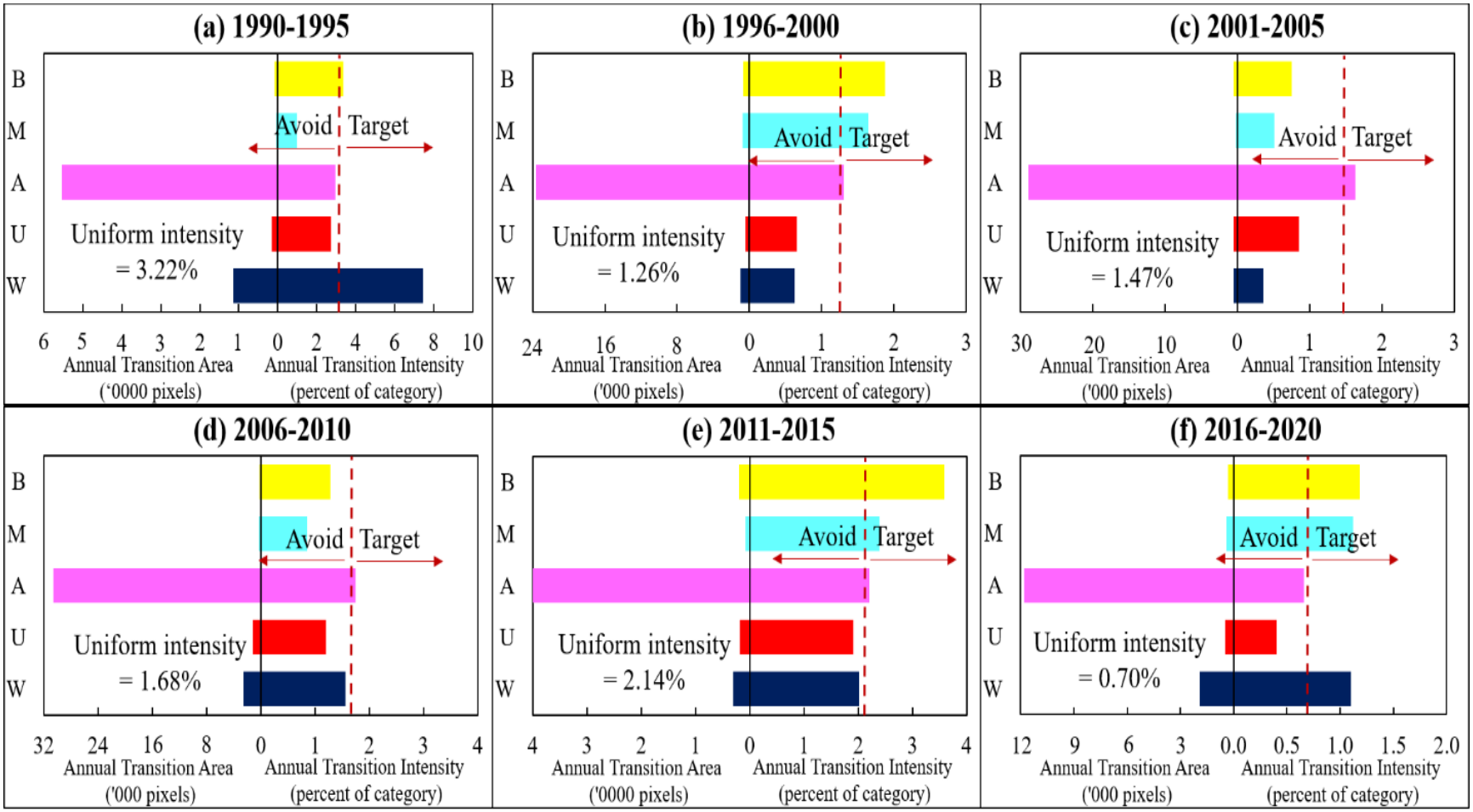
LULC Change

Category intensity change



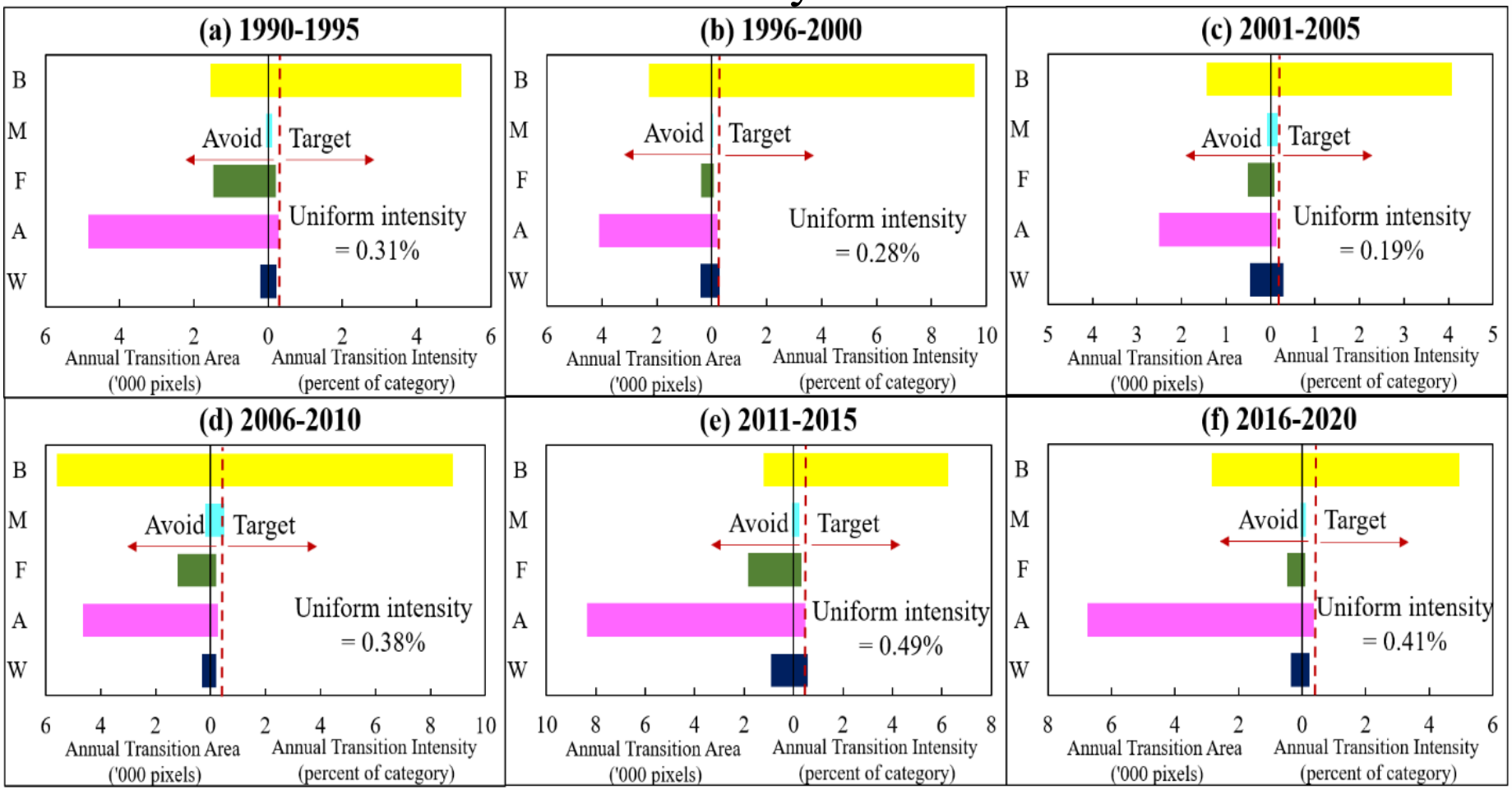
LULC Change

Transition analysis from Forest



LULC Change

Transition analysis to Urban

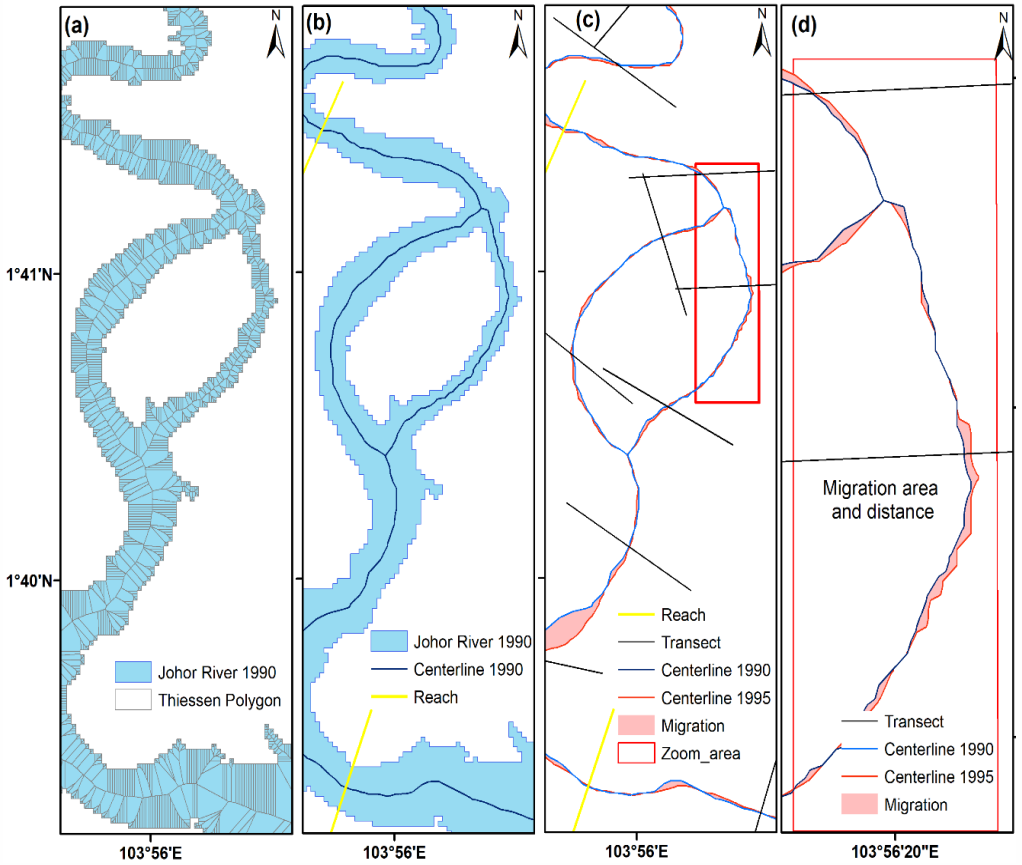


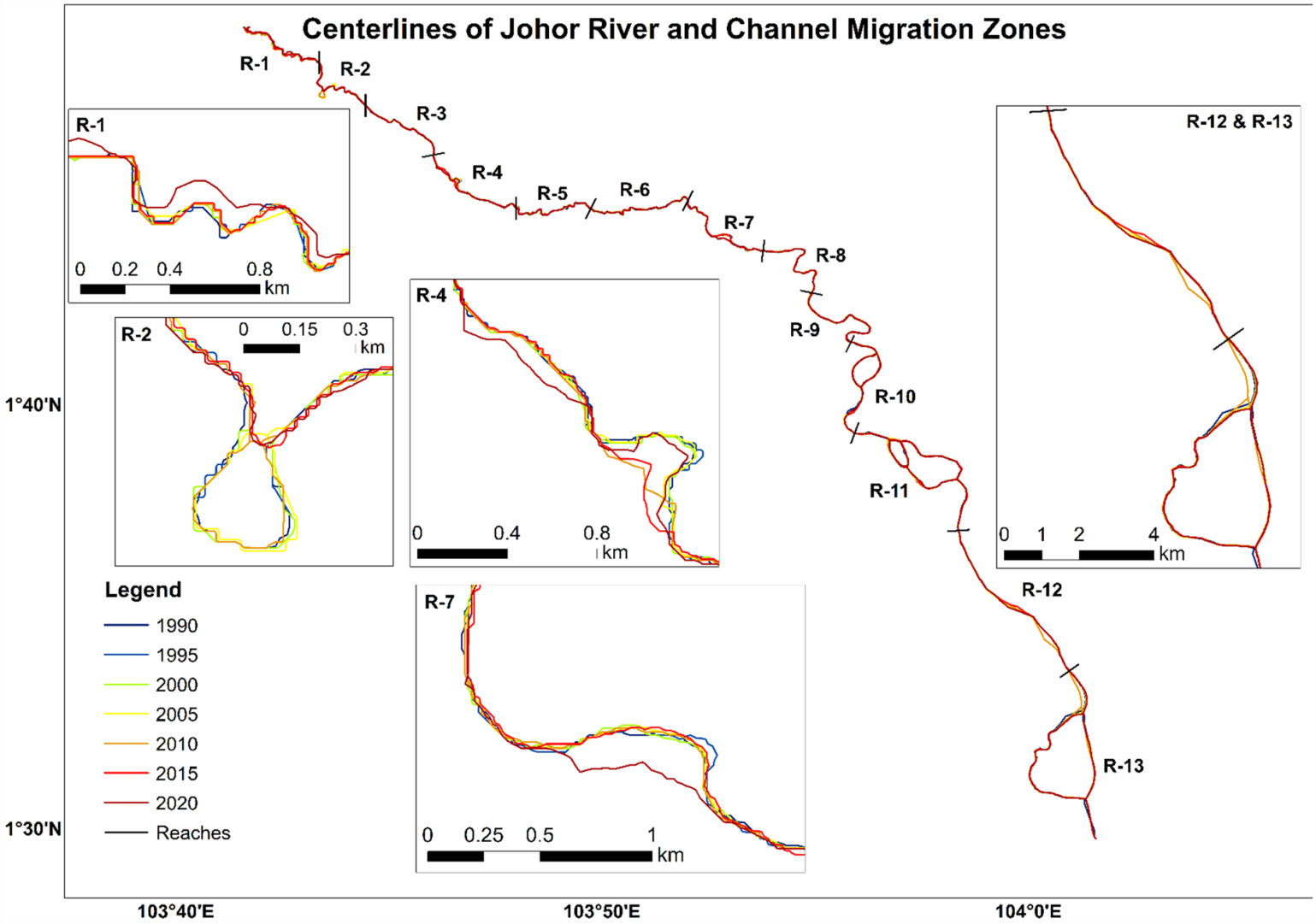
River morphology Change

River migration analysis

➢Converted raster classification maps to vector polygons

- ➢ Extracted polygons of water bodies
- ➢ Focussed on Johor river only
- ➢ Computed the area of Johor river
- ➢ Generate Thiessen polygons
- ➢ Extract river center lines
- ➢ Overlay river center lines derived from different years to identify center line migration
- ➢ The river was divided into 13 reaches (sections) and several transects within each reach
- ➢ Analysis of migration distance and area

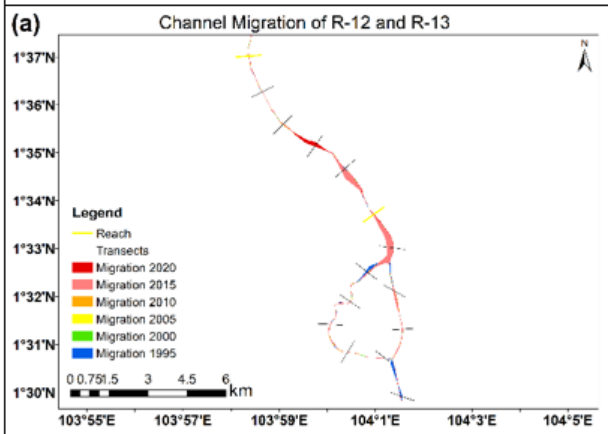
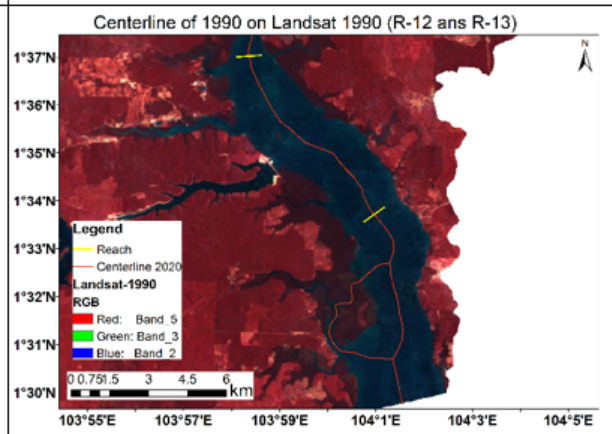
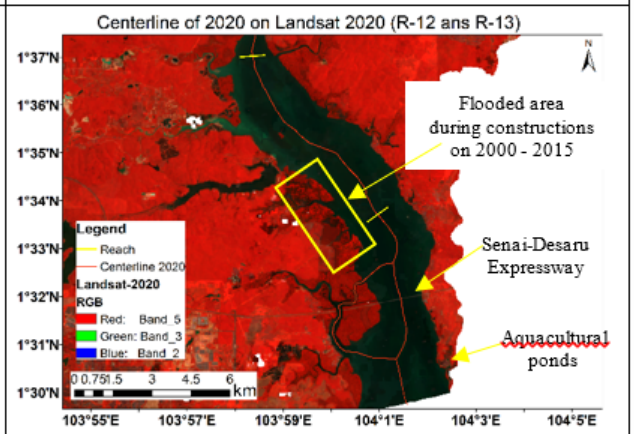



Centerlines of Johor River and Channel Migration Zones
R-1
R-2
R-3
R-4
R-5
R-6
R-7
R-8
R-9
R-10
R-11
R-12
R-13
R-12 & R-13
0 1 2 4 km
0 0.2 0.4 0.8 km
0 0.15 0.3 km
0 0.4 0.8 km
0 0.25 0.5 1 km
Legend
1990
1995
2000
2005
2010
2015
2020
Reaches
1°40'N
1°30'N
103°40'E
103°50'E
104°0'E

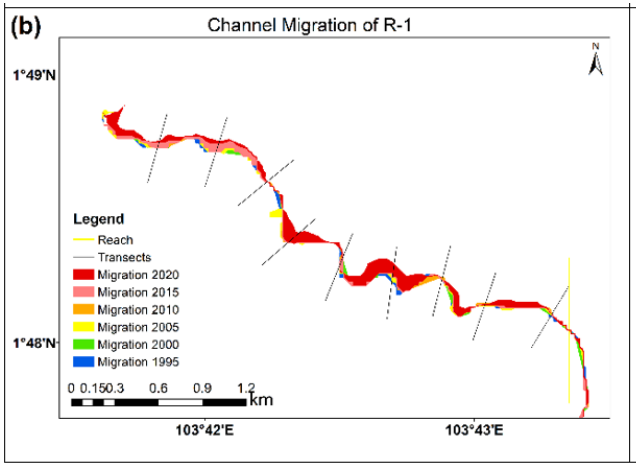
(a)	Migration Area (m^2)													Total	No. of polygons
	R-1	R-2	R-3	R-4	R-5	R-6	R-7	R-8	R-9	R-10	R-11	R-12	R-13		
1995	42953.0	42739.2	27461.0	38559.3	41442.1	45726.2	42956.9	36742.3	42553.3	112537	88916.3	77733.5	377207.2	1017528	570
2000	31248.7	18989.1	21061.3	30286.5	31006.9	20599.0	38734.5	21523.5	23008.5	48742.5	32665.3	69125.1	111617	498609	501
2005	60117.5	44103.3	49065.7	43167.6	45974.0	48029.5	50176.2	29957.0	34315.8	53195.0	89019.4	69230.1	116250	732601	603
2010	46086.0	49651.4	43643.0	88633.7	38652.6	37321.6	42218.9	29913.3	29029.3	62590.6	86379.2	349704	562878	1466703	659
2015	68220.5	87062.9	41337.9	59406.6	43572.5	45785.7	60174.8	53836.5	48818.9	75757.8	169984.1	412795.8	687132.3	1853886	448
2020	145134	42224.5	44451.4	130976	48892.2	45378	156334	47909.4	43709.9	89785.9	152751	209662	131298	1288510	439
	393760	284770	227020	391030	249540	242840	390596	219882	221435	442609	619715	1188251	1986383		

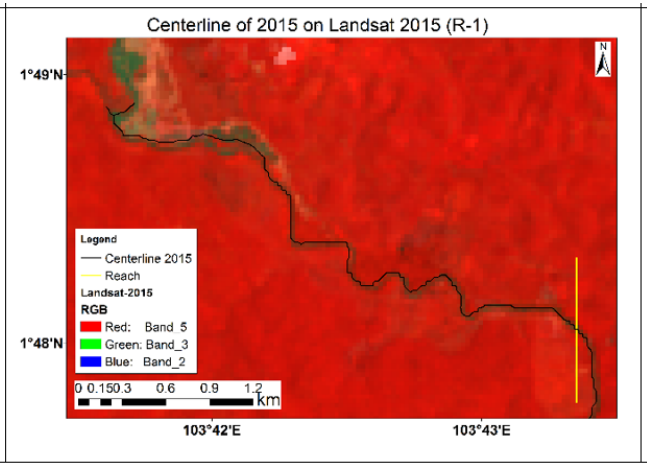
(b)	Mean Migration Distance (m)													Total	
	R-1	R-2	R-3	R-4	R-5	R-6	R-7	R-8	R-9	R-10	R-11	R-12	R-13		
1995	14.66	35.12	11.17	14.70	21.65	7.90	2.19	8.30	19.70	10.54	11.72	6.79	41.27	205.72	
2000	14.21	7.92	14.99	17.32	12.86	9.97	9.55	6.31	12.78	11.51	4.47	3.12	9.03	134.03	
2005	13.52	15.18	13.86	9.00	11.87	13.09	10.50	4.52	6.52	12.14	8.80	8.50	11.34	138.84	
2010	12.10	21.00	9.96	33.98*	6.85	7.43	9.58	6.00	2.80	6.53	46.22	8.60	44.58	215.62	
2015	17.28	45.25*	12.51	7.80	9.16	14.50	17.20	12.38	12.33	9.26	26.66	56.89	57.93	299.15	
2020	41.30*	10.33	15.47	38.30*	6.83	15.22	40.92*	14.39	4.33	8.35	28.75	34.01	12.68	270.86	
	113.06	134.80	77.96	121.09	69.22	68.10	89.94	51.89	58.46	58.33	126.62	117.92	176.84		

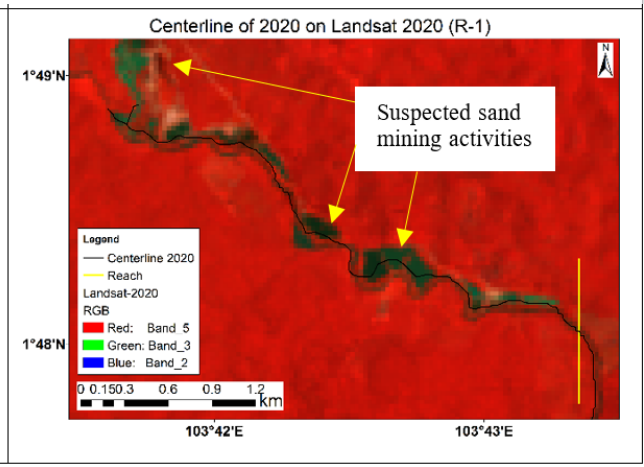
*Values selected for detail analysis on migration distance.

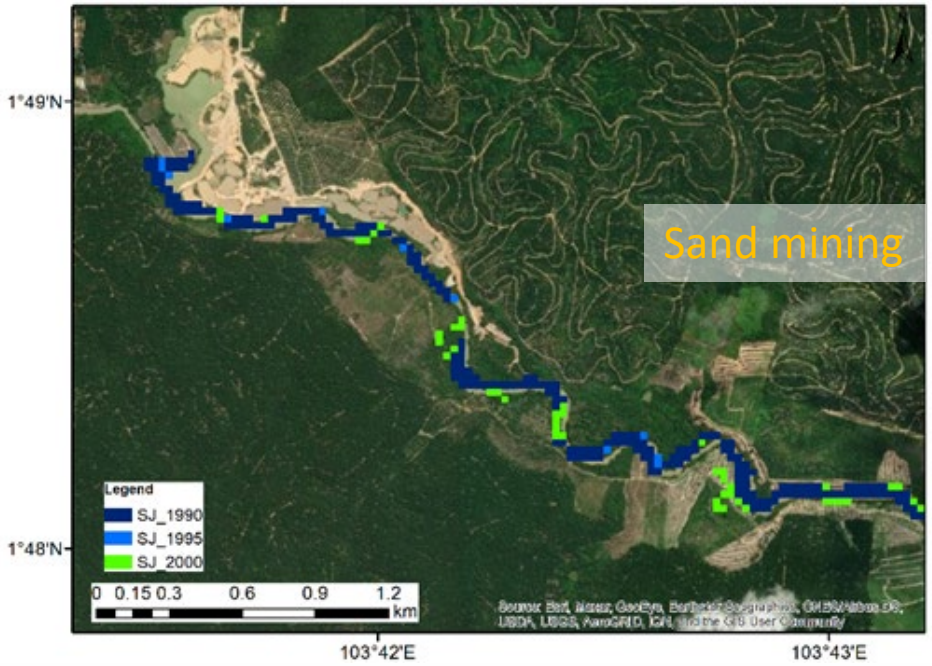
Channel Migration	Initial condition	Migrated condition
		

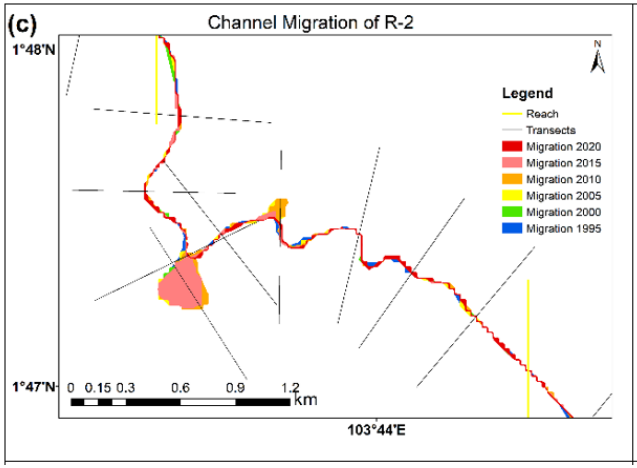
Channel migration area in 30 years: 1-2 km^2

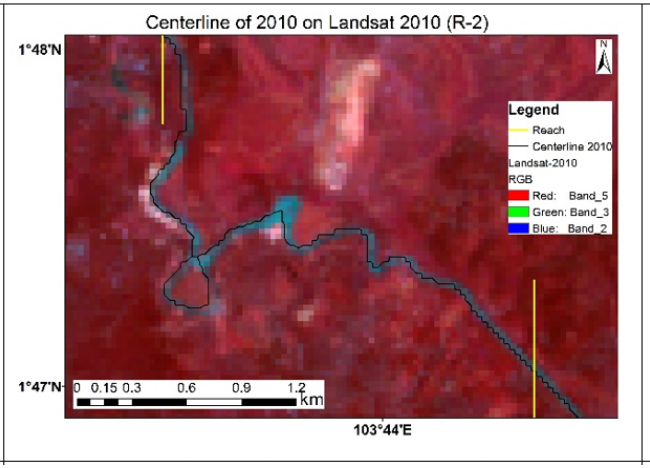

(b)
Channel Migration of R-1
1°49'N
1°48'N
103°42'E
103°43'E
N
Legend
Reach
Transects
Migration 2020
Migration 2015
Migration 2010
Migration 2005
Migration 2000
Migration 1995
0 0.150.3 0.6 0.9 1.2
km

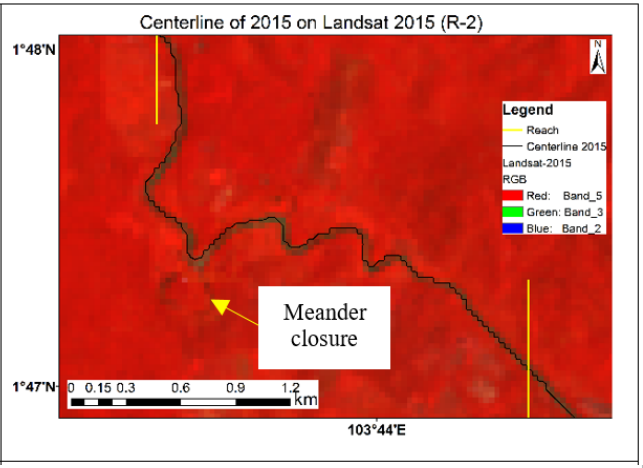

Centerline of 2015 on Landsat 2015 (R-1)
1°49'N
1°48'N
103°42'E
103°43'E
N
Legend
Centerline 2015
Reach
Landsat-2015
RGB
Red: Band_5
Green: Band_3
Blue: Band_2
0 0.150.3 0.6 0.9 1.2
km

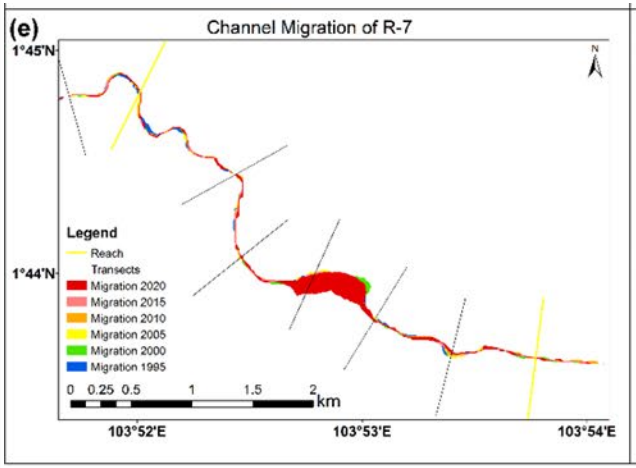

Centerline of 2020 on Landsat 2020 (R-1)
Suspected sand mining activities
1°49'N
1°48'N
103°42'E
103°43'E
N
Legend
Centerline 2020
Reach
Landsat-2020
RGB
Red: Band_5
Green: Band_3
Blue: Band_2
0 0.150.3 0.6 0.9 1.2
km

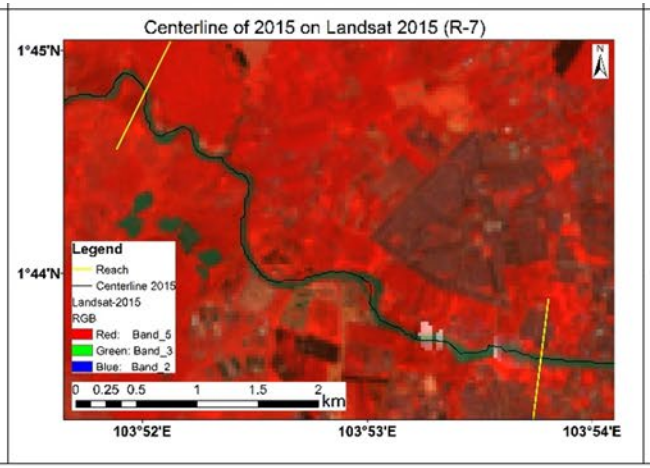

Sand mining
1°49'N
1°48'N
103°42'E
103°43'E
Legend
SJ_1990
SJ_1995
SJ_2000
0 0.15 0.3 0.6 0.9 1.2
km

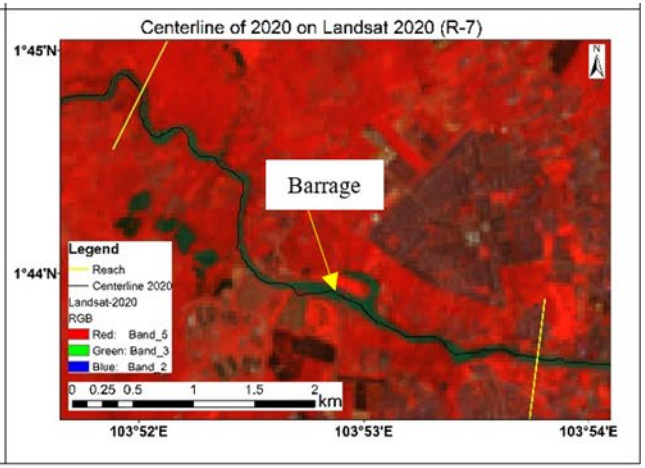

(c)
Channel Migration of R-2
1°48'N
1°47'N
103°44'E
Legend
Reach
Transects
Migration 2020
Migration 2015
Migration 2010
Migration 2005
Migration 2000
Migration 1995
0 0.15 0.3 0.6 0.9 1.2
km

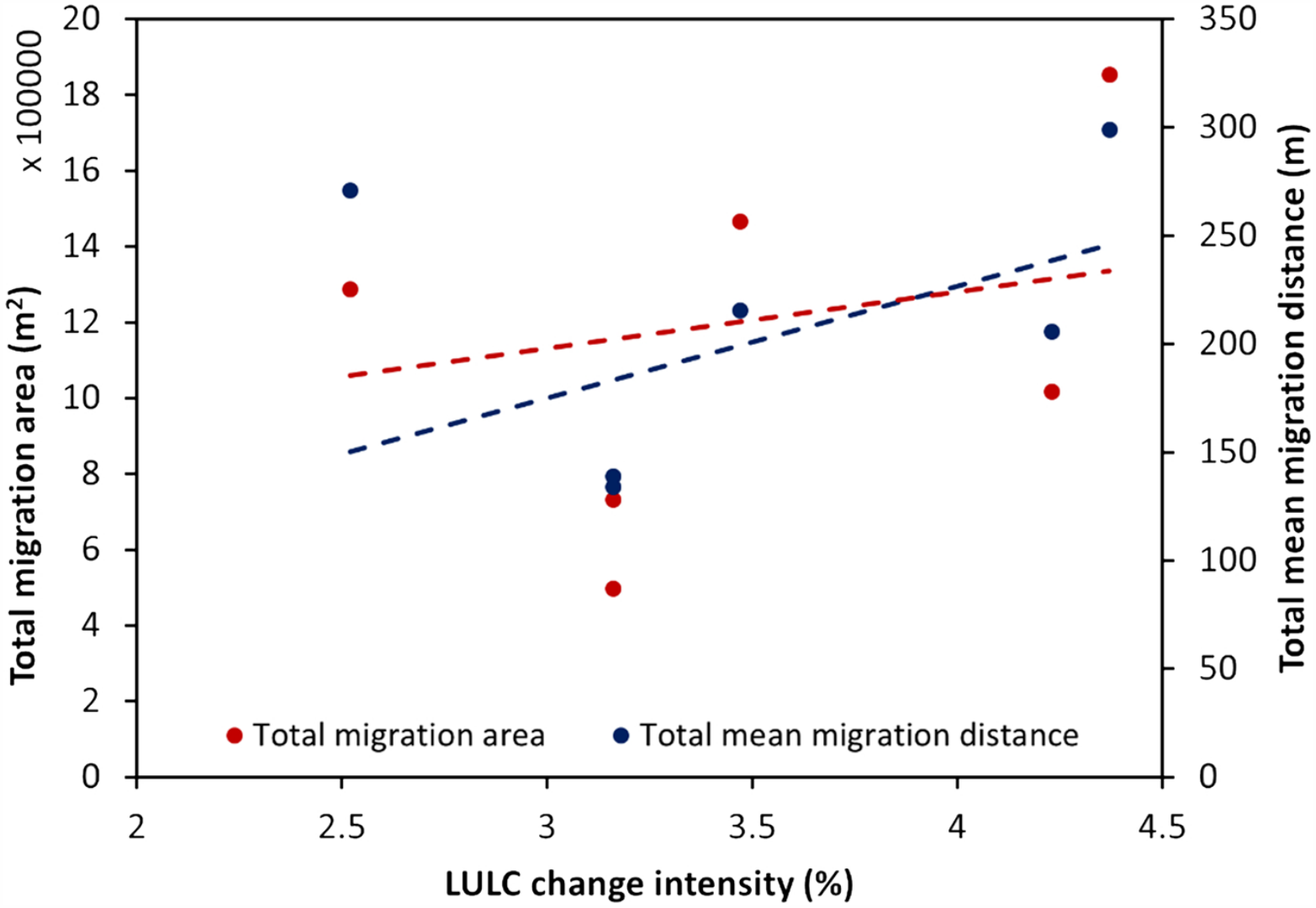

Centerline of 2010 on Landsat 2010 (R-2)
1°48'N
1°47'N
103°44'E
Legend
Reach
Centerline 2010
Landsat-2010
RGB
Red: Band_5
Green: Band_3
Blue: Band_2
0 0.15 0.3 0.6 0.9 1.2
km


Centerline of 2015 on Landsat 2015 (R-2)
1°48'N
1°47'N
103°44'E
Legend
Reach
Centerline 2015
Landsat-2015
RGB
Red: Band_5
Green: Band_3
Blue: Band_2
Meander closure
0 0.15 0.3 0.6 0.9 1.2
km


(e)
Channel Migration of R-7
1°45'N
1°44'N
N
Legend
Reach
Transects
Migration 2020
Migration 2015
Migration 2010
Migration 2005
Migration 2000
Migration 1985
0 0.25 0.5 1 1.5 2 km
103°52'E
103°53'E
103°54'E


Centerline of 2015 on Landsat 2015 (R-7)
1°45'N
1°44'N
N
Legend
Reach
Centerline 2015
Landsat-2015
RGB
Red: Band_5
Green: Band_3
Blue: Band_2
0 0.25 0.5 1 1.5 2 km
103°52'E
103°53'E
103°54'E


Centerline of 2020 on Landsat 2020 (R-7)
1°45'N
1°44'N
N
Barrage
Legend
Reach
Centerline 2020
Landsat-2020
RGB
Red: Band_5
Green: Band_3
Blue: Band_2
0 0.25 0.5 1 1.5 2 km
103°52'E
103°53'E
103°54'E


x 100000
Total migration area (m²)
Total mean migration distance (m)
LULC change intensity (%)
Total migration area
Total mean migration distance
0
2
4
6
8
10
12
14
16
18
20
50
100
150
200
250
300
350
2
2.5
3
3.5
4
4.5

Conclusion

- LULC changes of JRB and the changes of river morphology over the period 1990 to 2020 was conducted.
- SVM and RF were compared. High classification accuracy above 90% was achieved.
- SVM identified river lines better.
- The migration of river centerlines represents the changes of the river morphology over time.
- Anthropogenic activities i.e. sand mining, artificial meander closure, and barrage construction maybe responsible for morphological changes
- Understanding the impact of LULC and river morphology changes is important for
  - LULC planning and management
  - water security
  - sustainable livelihood protection.

Thank You

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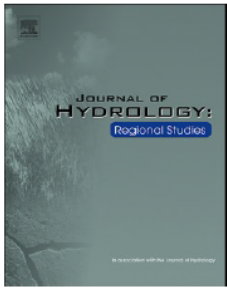

Land use and land cover change and its impact on river morphology in Johor River Basin, Malaysia

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