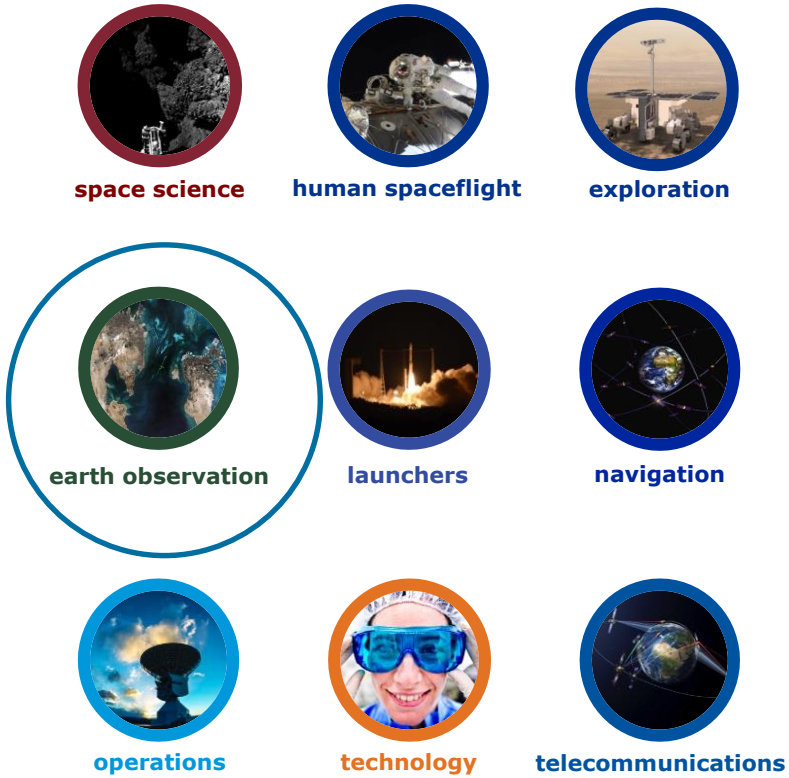
Earth observation tools enhance planning, climate-proofing in Mandalay

Paolo Manunta
ESA (European Space Agency) - Secondee in ADB

20 September 2017

Activities

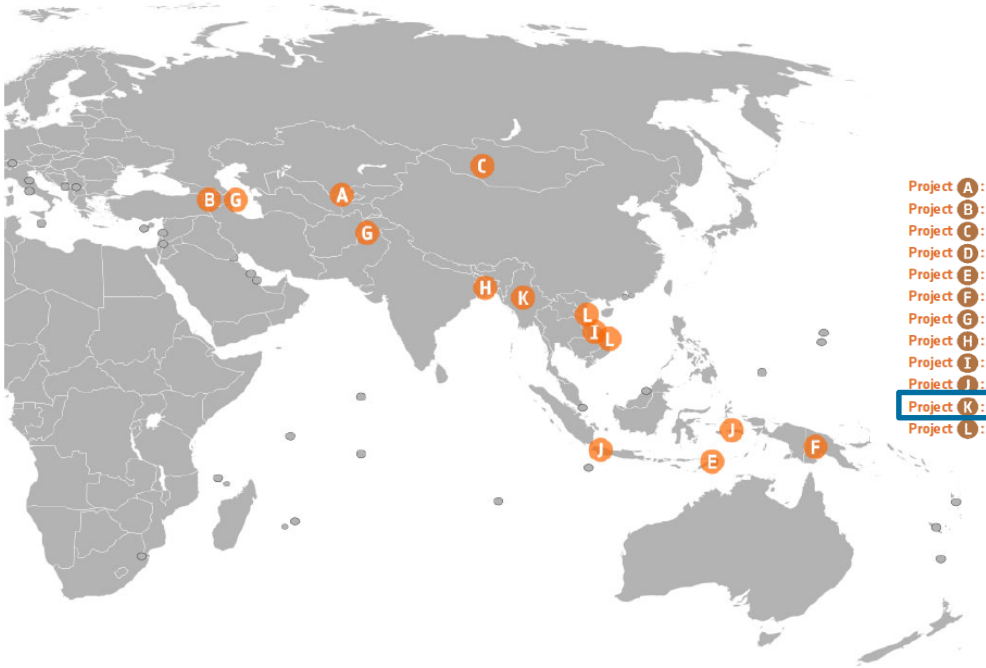
ESA is one of the few space agencies in the world to combine responsibility in nearly all areas of space activity.

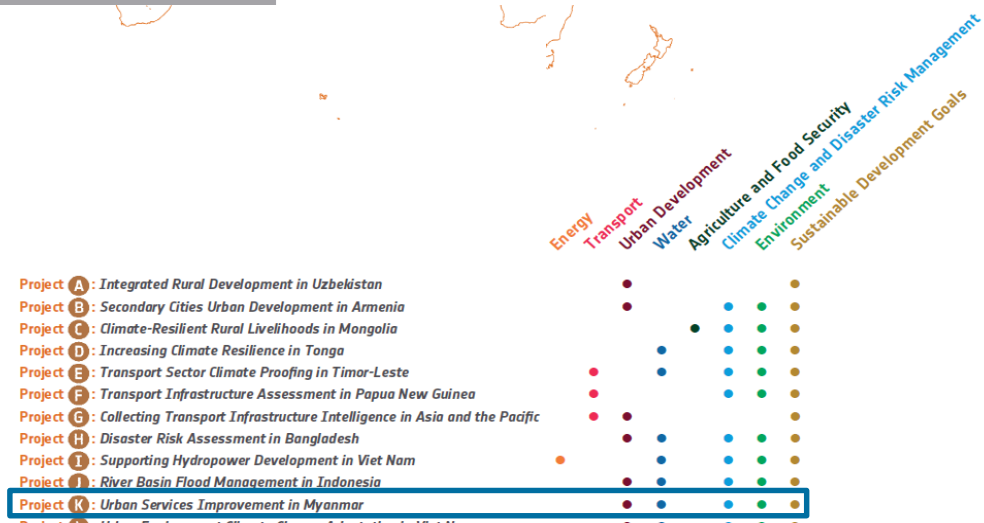


* Space science is a Mandatory programme, all Member States contribute to it according to GNP. All other programmes are Optional, funded 'a la carte' by Participating States.

EO support to 12 ADB projects during 2014-16 (eoTap initiative)

EOTAP: *EARTH OBSERVATION FOR A TRANSFORMING ASIA PACIFIC*
A PORTFOLIO OF TWELVE EO SUPPORT PROJECTS





Problem Statement

ADB's Mandalay Urban Services Improvement Project (MUSIP) for a better urban environment and public health:

- water supply system improvements
- enhanced drainage and flood protection
- improved wastewater management.

Myanmar is classified as having an "acute" overall climate change vulnerability factor up to 2030, based on the 2015 Global Climate Risk Index.

"These water supply and wastewater facilities have to be protected from floods."

Mandalay EOTAP services

Area of Interest (AOI)

Peri-urban and rural surroundings of Mandalay

(Irrawaddy and Myitinge valley)

<u>Rationale:</u>

Urban / regional trends in land development

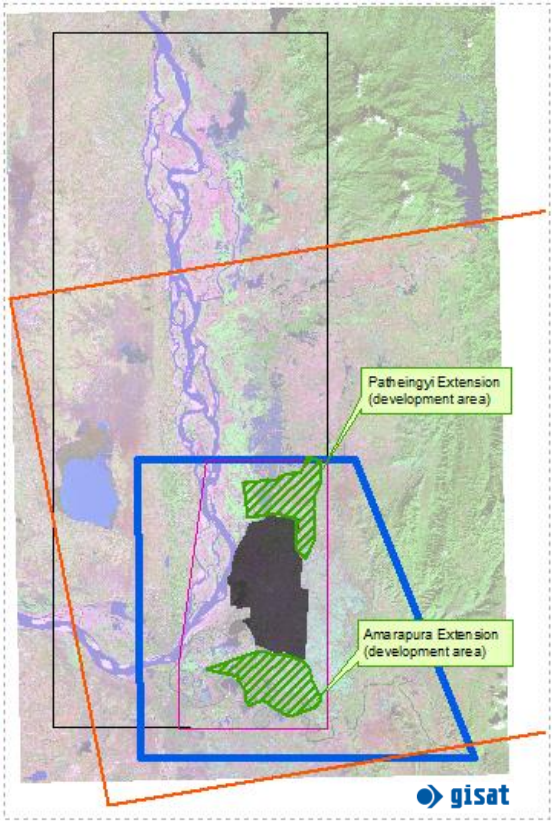
Extension of development zones

New constructions

Sprawl of settlements

Flood risk assessment

On settlements, agriculture and infrastructure



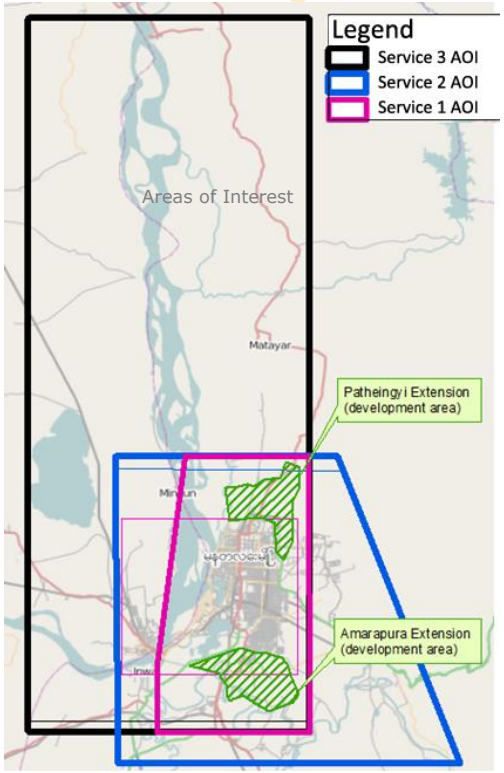
Deployment of EO Services

Service 1: Urban land use and land use change mapping
Available for February 2015 (based on Pléiades, 0.5 m resolution) and April 2002 (QuickBird, 1.5 m resolution)
Includes population census disaggregation and 3D building block analysis
Includes a data exploration tool for visualisation and analysis

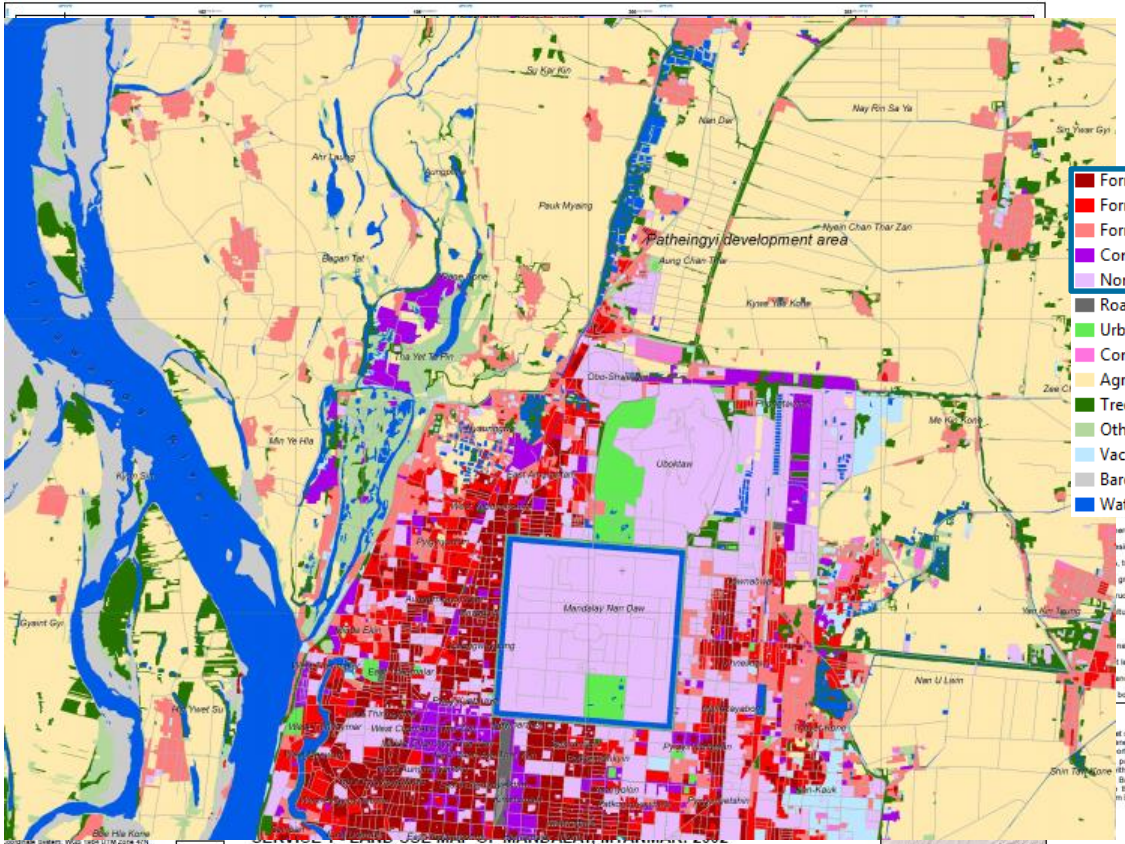
Service 2: Flood risk assessment
Extracted from optical and radar satellite imagery (ALOS PALSAR, SPOT 4/5) with 10-20 m resolution
Captures situation during peak monsoon flood inundation during 2003, 2006, 2007, 2008, 2009, 2010
Modelled using very high resolution Digital Elevation Model (based on SPOT-7 tri-stereo) for 10/50/100-year flood frequency

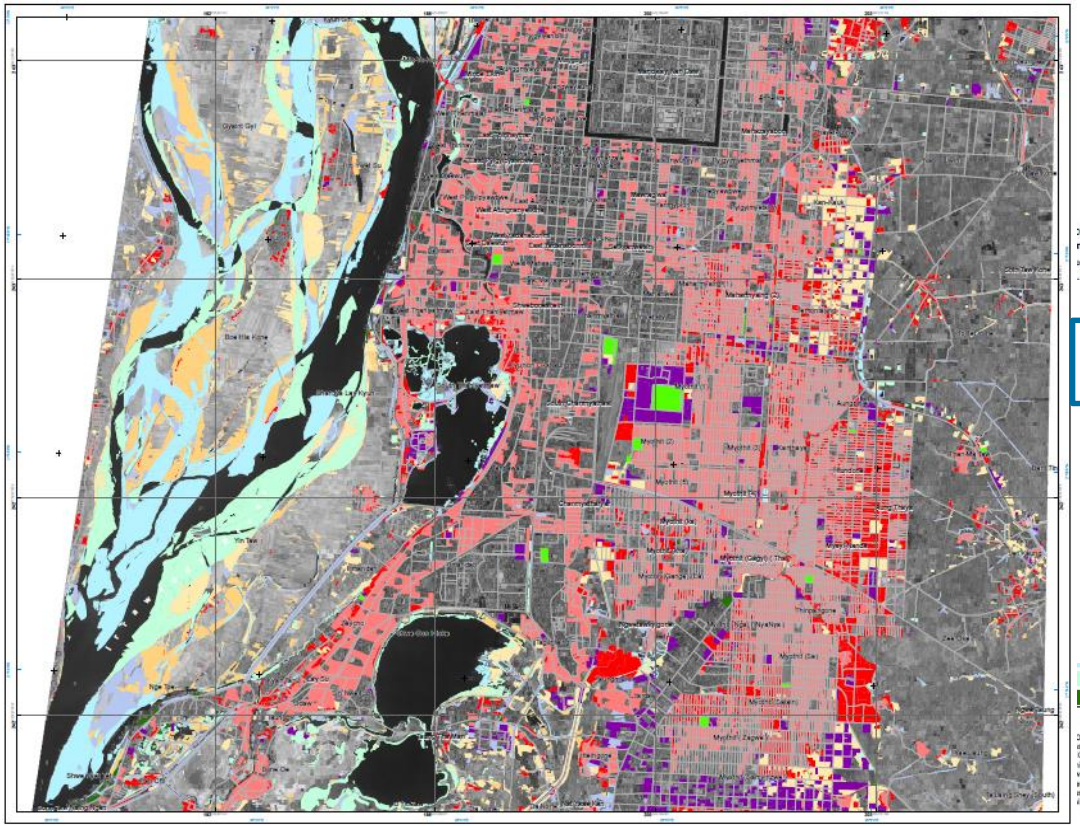
Service 3: Regional land use and land cover change mapping
Larger-scale but lower-resolution mapping (15 m)
Available for December 2013 (Landsat-8) and November 2000 (Landsat-7)

Service 4: On-demand demonstration of rapid flood mapping
Flood situation as of July-September 2015 monitored using the new European Sentinel-1 SAR satellite with 20 m resolution



Service 4 was delivered for Service 2 AOI (Mandalay) and Kalaymyo area in western Saigaing district


Patheingyi development area
Mandalay Nan Daw
Ubolkan
Formal very high denstity residential (Sealing Level > 80 %)
Formal high denstity residential (Sealing Level: 50 – 80 %)
Formal low density residential (Sealing Level: 10 – 50 %)
Commercial and industrial units
Non-residential urban fabric
Roads, transportation units and associated areas
Urban greenery
Construction sites
Agriculture
Trees
Other natural and semi-natural areas incl. wetlands
Vacant land not obviously beying prepared for construction
Bare land
Water bodies
Mapsheet 2
1:28 000
1 cm = 280 m

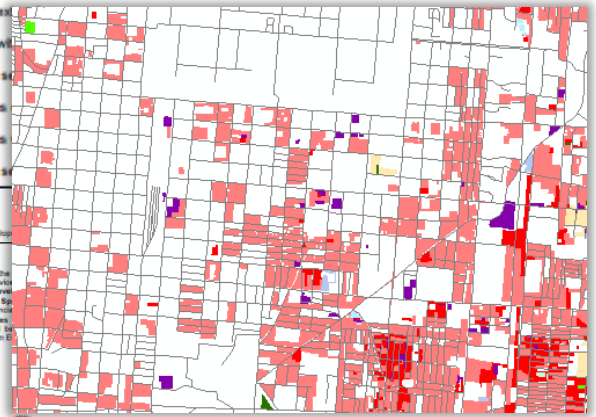


SERVICE 1 - LAND USE CHANGE MAP OF MANDALAY, MYANMAR: 2002 - 2014/2015
Mapsheet 2

1:28 000
1 cm = 280 m

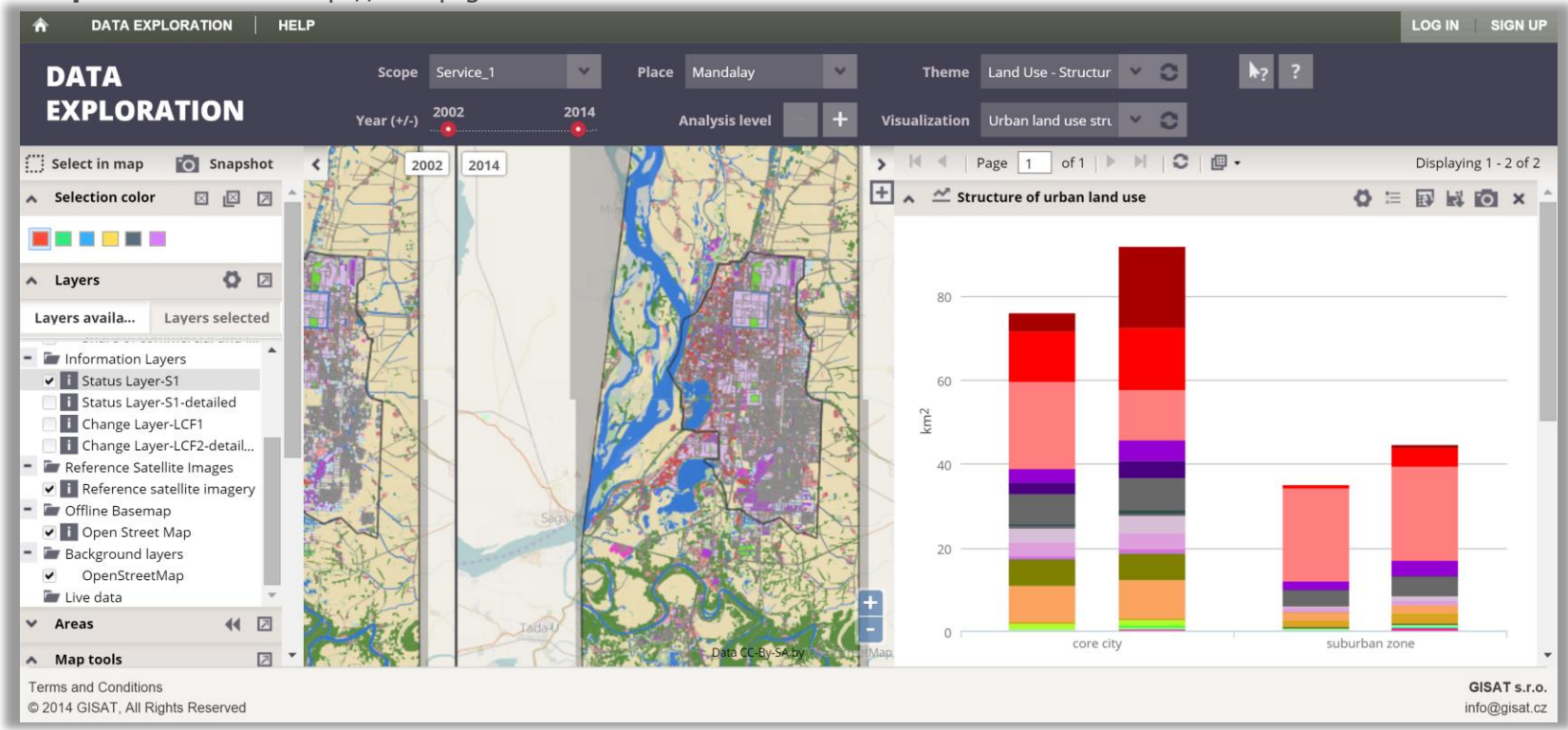
Haymarzala - Ward name

Urban extension: extension of residential urban fabric
Urban extension: extension of non-residential urban fabric
Urban extension: extension of urban greenery
Internal urban development
Agriculture ex
Agriculture wi
Natural and s
Water bodies
Water bodies
Natural and s
Water bodies withdrawal
Natural and semi-natural develop



Service 1: Urban land use and land use change mapping – Examples

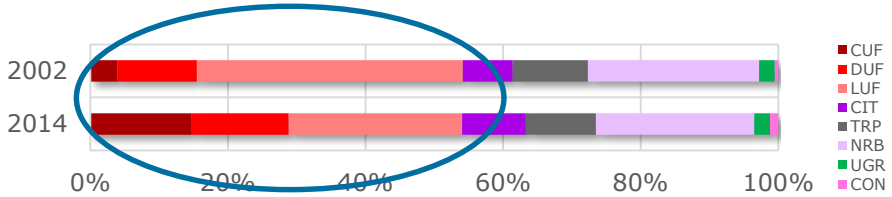
Web-based **Data Exploration Tool** http://eotap.gisat.cz

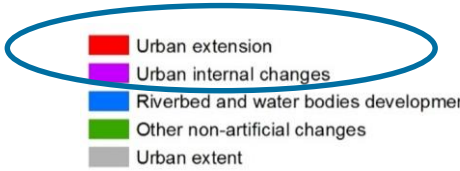


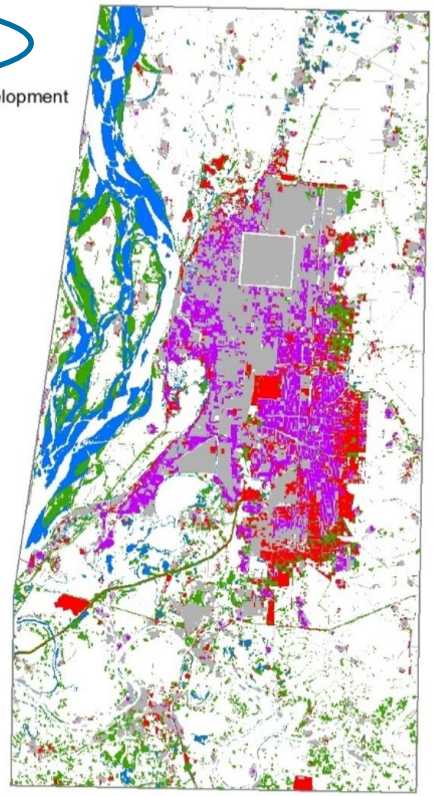
Service 1: Urban land use and land use change mapping – Examples

Statistics based on data exploration tool

Structure of urban land use classes in years 2002 and 2014
(100% = Service 1 Urban area)





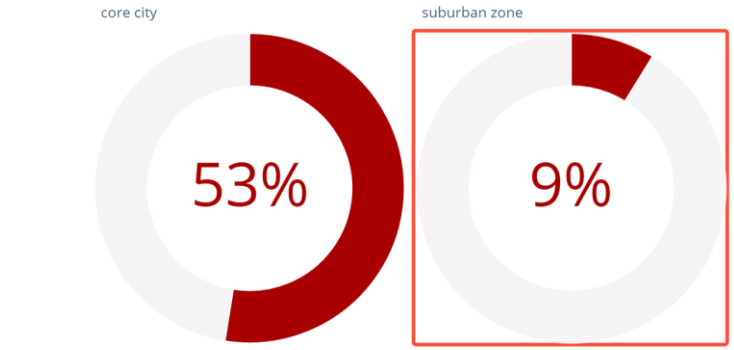


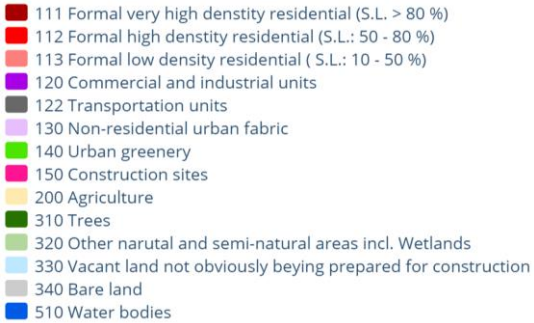
Formal very high denstity residential (Sealing Level > 80 %)
Formal high denstity residential (Sealing Level: 50 – 80 %)
Formal low density residential (Sealing Level: 10 – 50 %)
Commercial and industrial units
Non-residential urban fabric
Roads, transportation units and associated areas
Urban greenery
Construction sites
Agriculture
Trees
Other natural and semi-natural areas incl. wetlands
Vacant land not obviously beying prepared for construction
Bare land
Water bodies

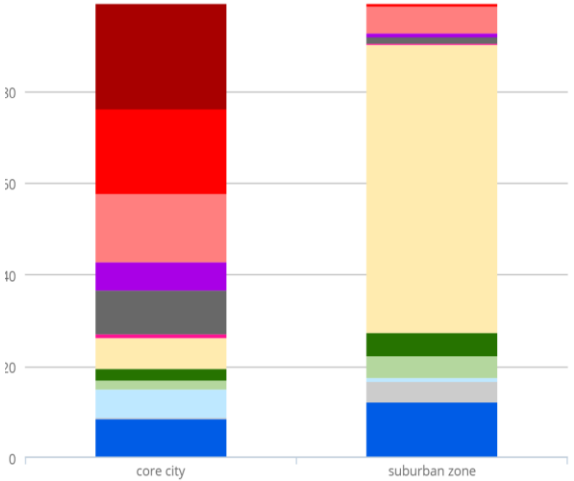
Statistics based on data exploration tool

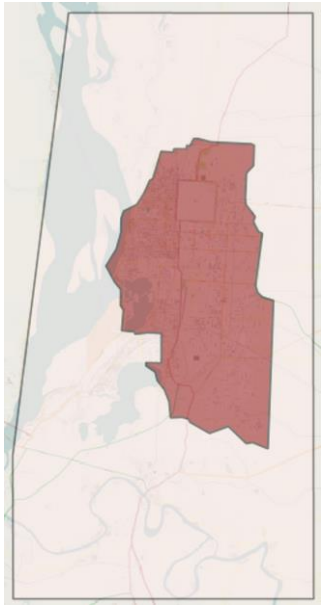
Share of **urban area** and **land use structure**

- Core city and suburban zone comparison



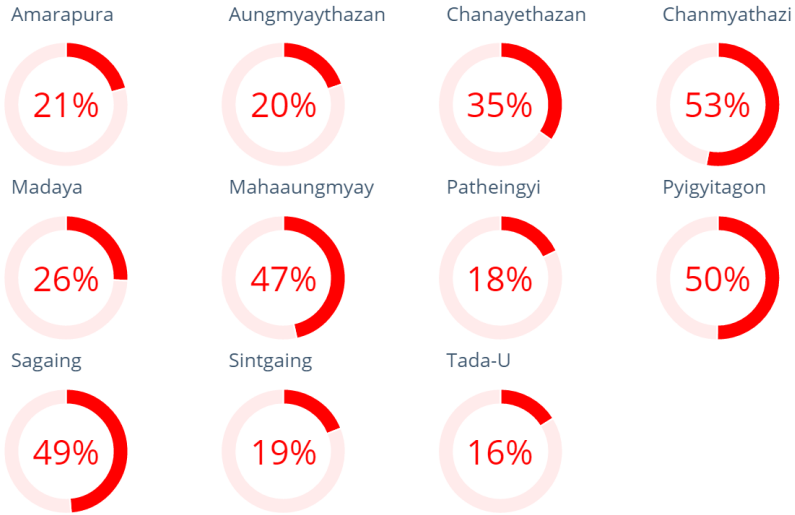


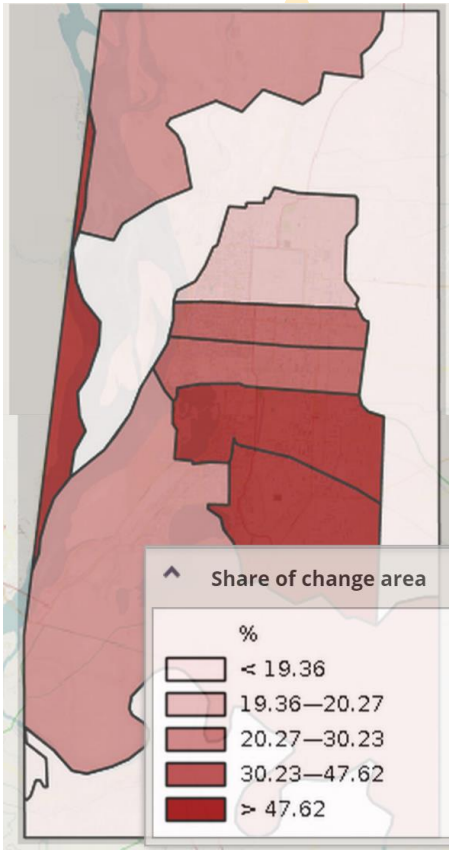




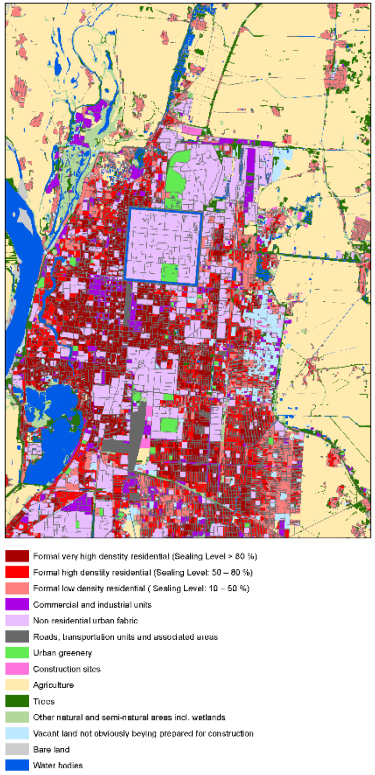
Statistics based on data exploration tool

Share of **changed area** (2002–2015) per total area (Ward-level comparison)

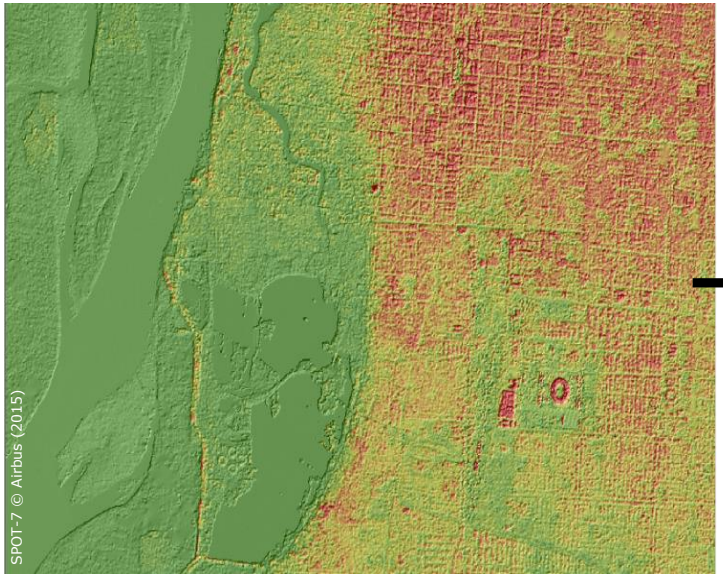




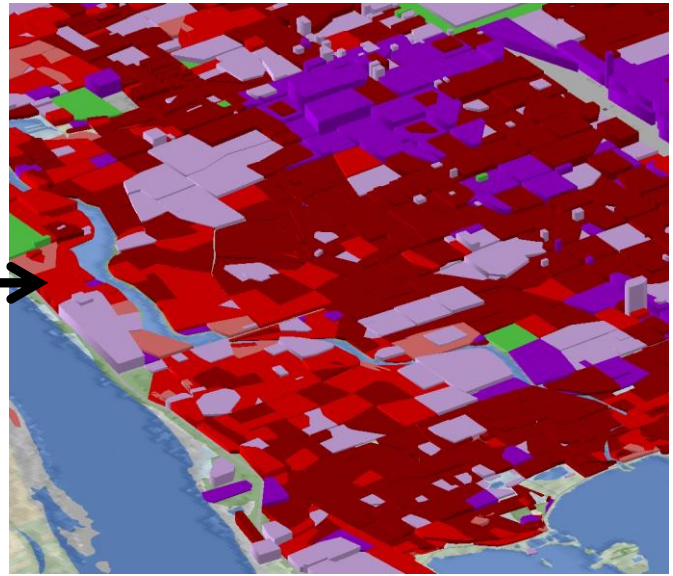
Service 1+2: Urban land use and land use change mapping – Examples



Combining the land cover information from Service 1 with the elevation data from Service 2



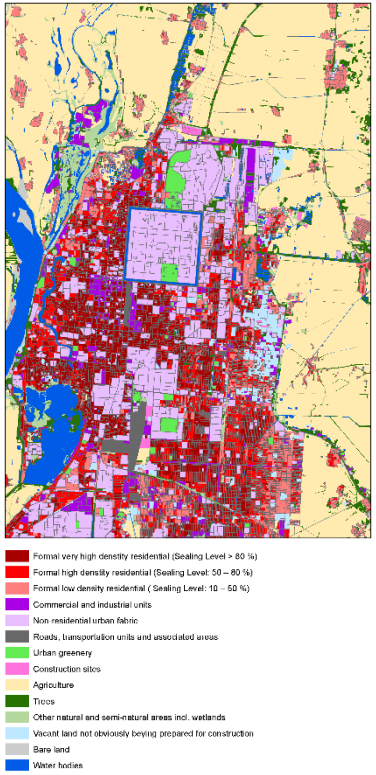
Digital surface model from satellite tri-stereo



Building block 3D city plan

gisat

Service 1: Urban land use and land use change mapping – Examples

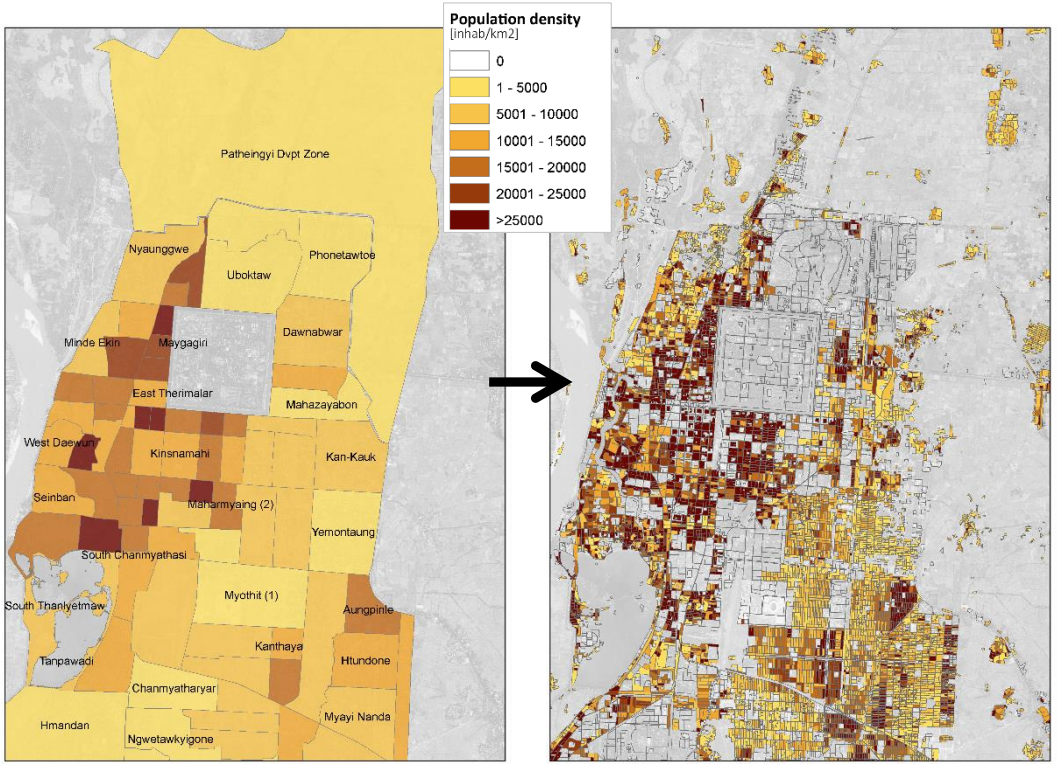


Population disaggregation

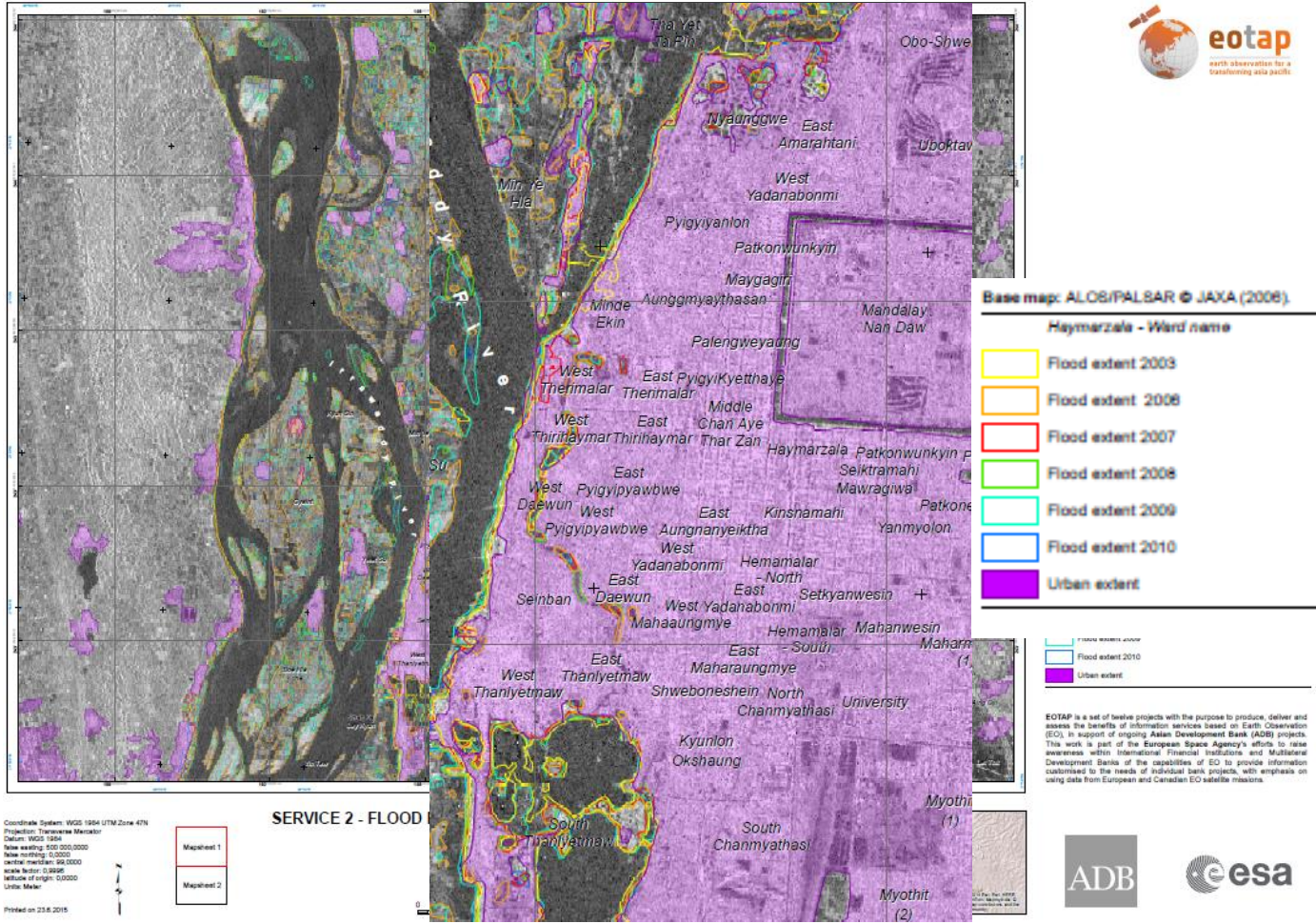
Population census data available at administrative (ward) level

Disaggregation of population density to residential building block level:
Built-up density
Building block typology
Building block average height

First approximation only, but gives already a better insight into population distribution patterns



gisat



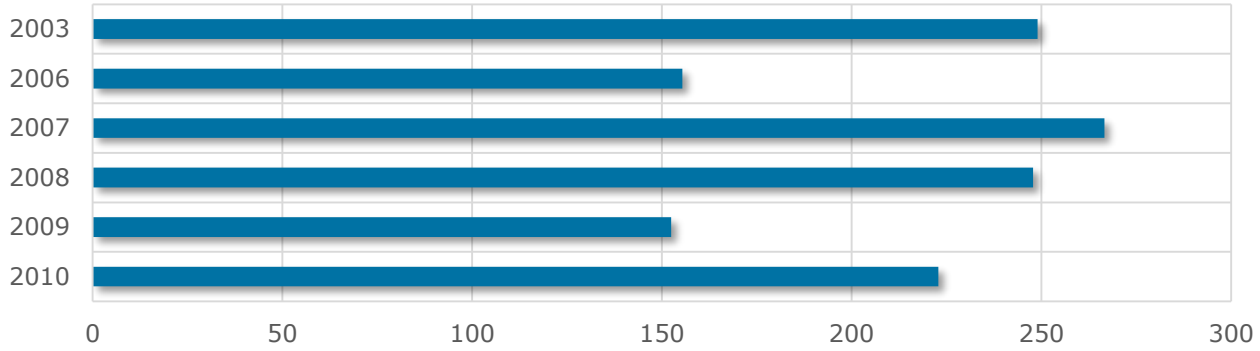
SERVICE 2 - FLOOD

Coordinate System: WGS 1984 UTM Zone 47N
Projection: Transverse Mercator
Datum: WGS 1984
false easting: 500 000,0000
false northing: 0,0000
central meridian: 99,0000
scale factor: 0,9996
latitude of origin: 0,0000
Units: Meter

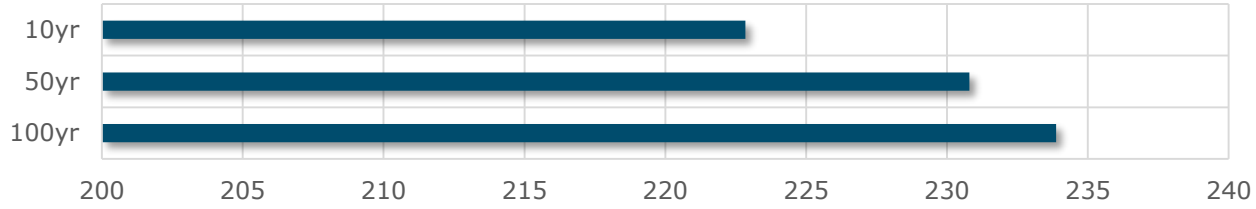
Printed on 23.6.2015

Mapsheet 1
Mapsheet 2

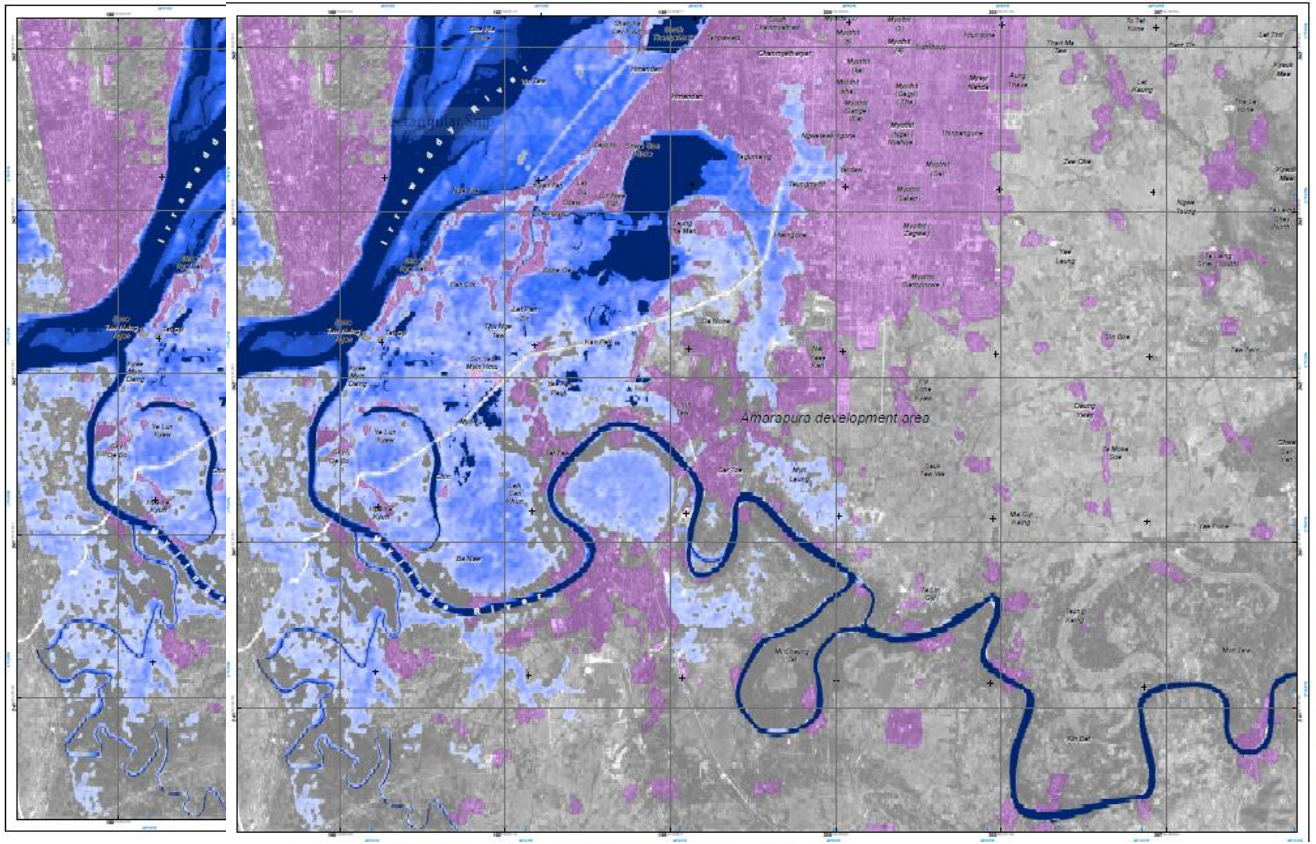
EOTAP is a set of twelve projects with the purpose to produce, deliver and assess the benefits of information services based on Earth Observation (EO), in support of ongoing **Asian Development Bank (ADB)** projects. This work is part of the **European Space Agency's** efforts to raise awareness within International Financial Institutions and Multilateral Development Banks of the capabilities of EO to provide information customised to the needs of individual bank projects, with emphasis on using data from European and Canadian EO satellite missions.



Measured (Km^2)



Modelled (Km^2). Should we expect higher values ?



EOTAP project:
Projekt K: Urban Services Improvement in M

Contractor(s): GISAT s.r.o. (Czech Republic)

Interpretation: The flood height map shows water d
inundation as modelled for hypothetic **100-yr recurrent**
Irrawaddy River in Mandalay city area, Myanmar. Modelling
using HEC-RAS 1-D flood model which facilitated multiple
100-yr river discharge related to Saigaing river gauge
elevation model extracted from Spot-7 tri-stereo ima
01.02.2015, land cover classes affecting surface roughn
river profile cross sections. 10- and 50-yr inundations wer
both modelled extents were comparable to 100-yr, differenc
was ~0.6m and ~0.15m for 10- and 50-yr models respectivel

Image data: Spot-7 tri-stereo © Airbus (2015)

Vector data: © OSM (2015), ancillary data and toponyms
(2015).

Base map: Spot-7 tri-stereo © Airbus (2015)

Digital Elevation Model: Fine-resolution DEM (6m pixel s
from Spot-7 tri-stereo © Airbus (2015)

Haymarzale - Ward name

Flood height (m)

- 1
- 2
- 4
- 6
- 8
- 10
- 12
- 14

Reference water extent as of 01.02.2015

Urban extent

EOTAP is a set of twelve projects with the purpose to prod
assess the benefits of information services based on Ea
(EO), in support of ongoing **Asian Development Bank**
This work is part of the **European Space Agency's**
ewareness within International Financial Institutions
Development Banks of the capabilities of EO to prov
customised to the needs of individual bank projects, wit
using data from European and Canadian EO satellite missi

Coordinate System: WGS 1984 UTM Zone 47N
Projection: Transverse Mercator
Datum: WGS 1984
false easting: 500 000,0000
false northing: 0,0000
central meridian: 99,0000
scale factor: 0,9996
latitude of origin: 0,0000
Units: Meter

Printed on 23.6.2015

Mapsheet 1

Mapsheet 2

SERVICE 2 - FLOOD HEIGHT MAP IN MANDALAY AREA, MYANMAR
Mapsheet 2

1:38 000

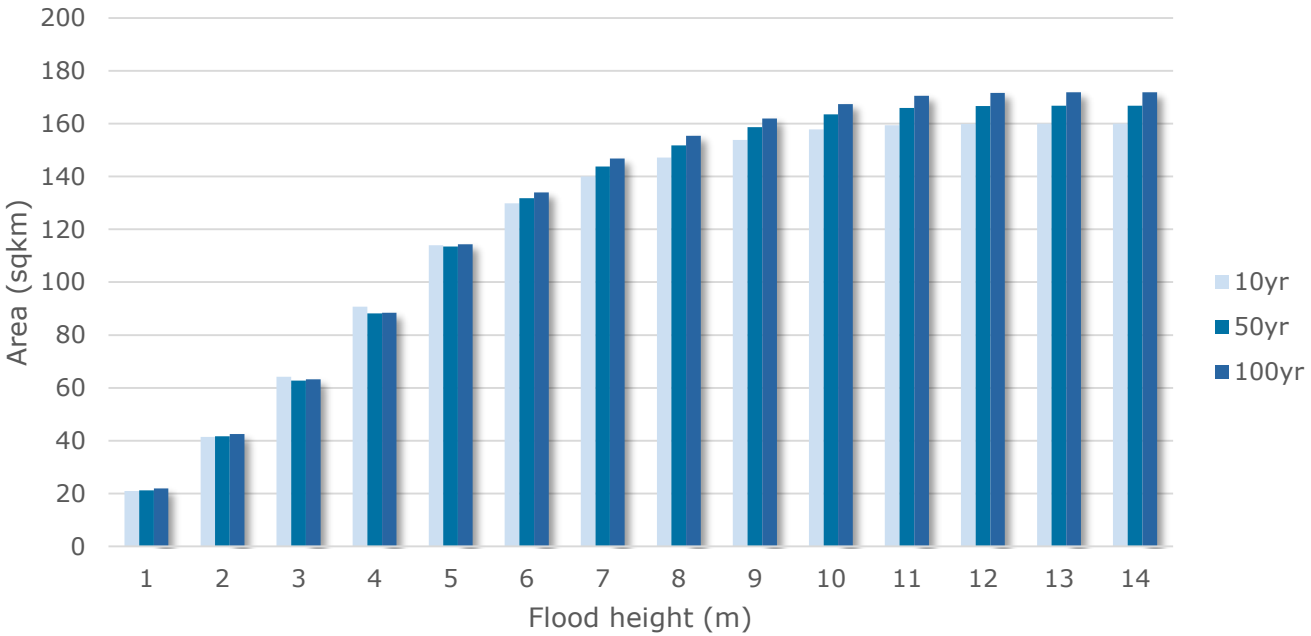
1 cm = 380 m

0 0,25 0,5 1 1,5 2 2,5 3 3,5 4 4,5 5 5,5 km

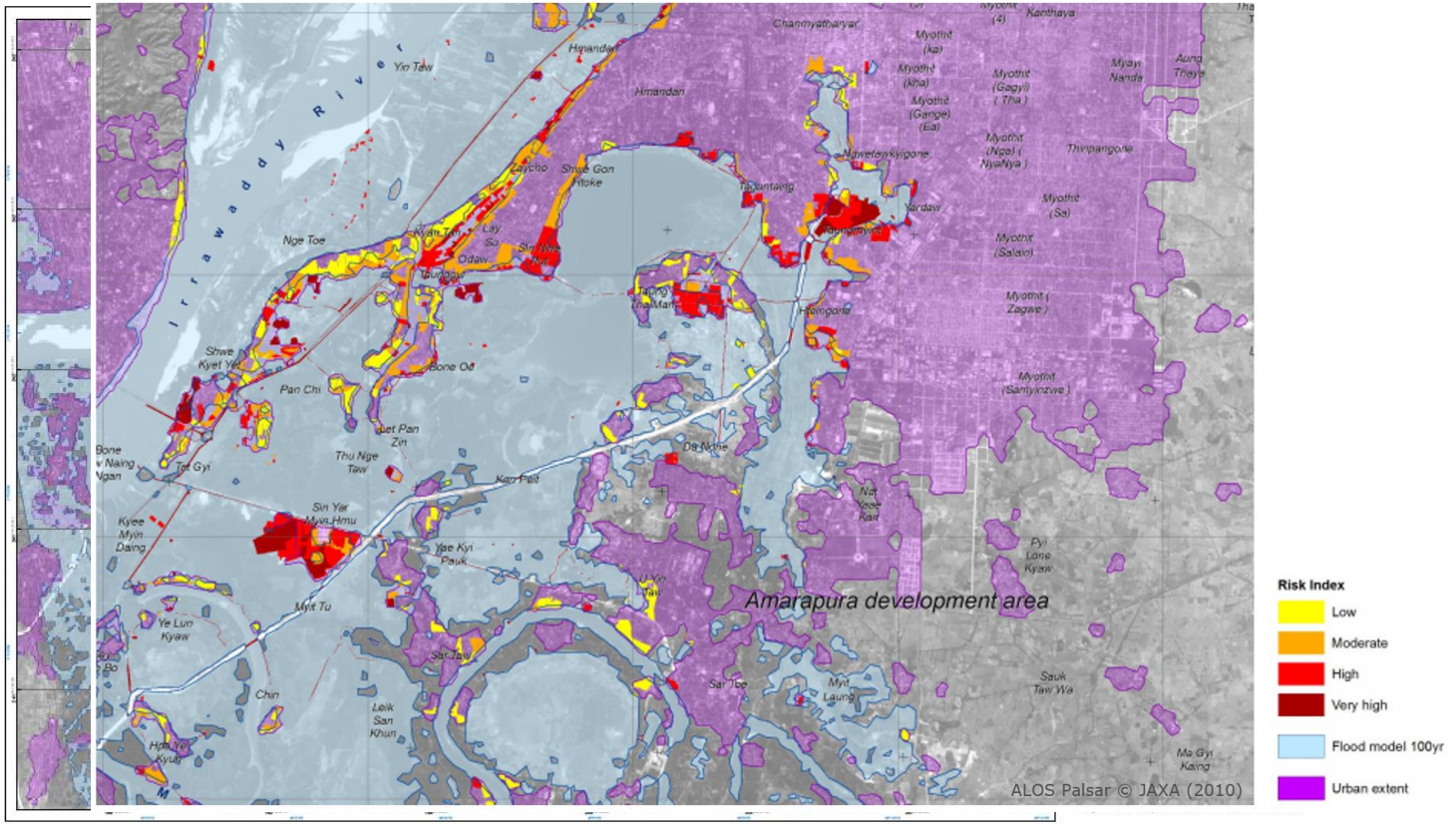
gisat

ADB

esa

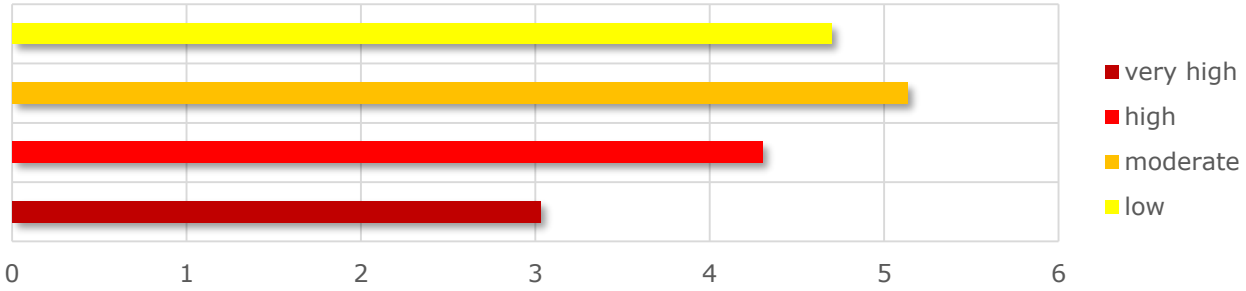

200
180
160
140
120
100
80
60
40
20
0
Area (sqkm)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Flood height (m)
10yr
50yr
100yr

Modelled



SERVICE 2 - FLOOD RISK ASSESSMENT IN MANDALAY AREA, MYANMAR
Mapsheet 2

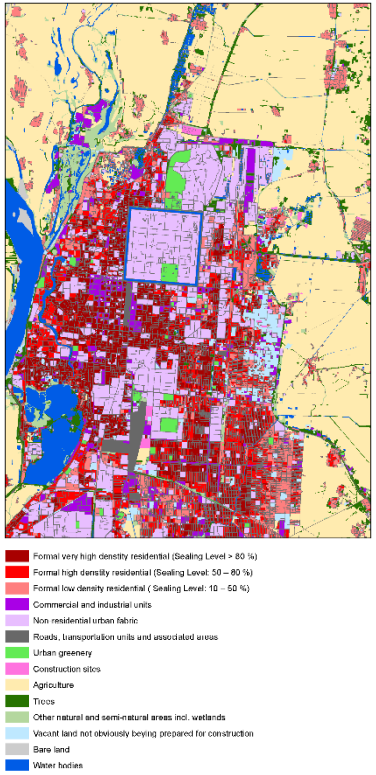
1:38 000
1 cm = 380 m



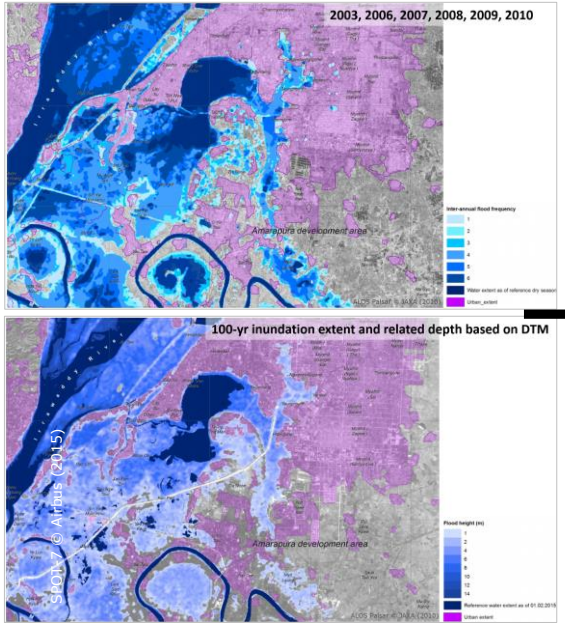
Up to 20 sqkm of urban areas (mainly rural settlements in the Irrawaddy riverbed) are endangered by inundation from hypothetic 100yr flood. Breakdown according to the risk level index is shown.

The rest of more than 150 sqkm belongs to inundation of agriculture, bare and natural land, mainly in the riverbed.

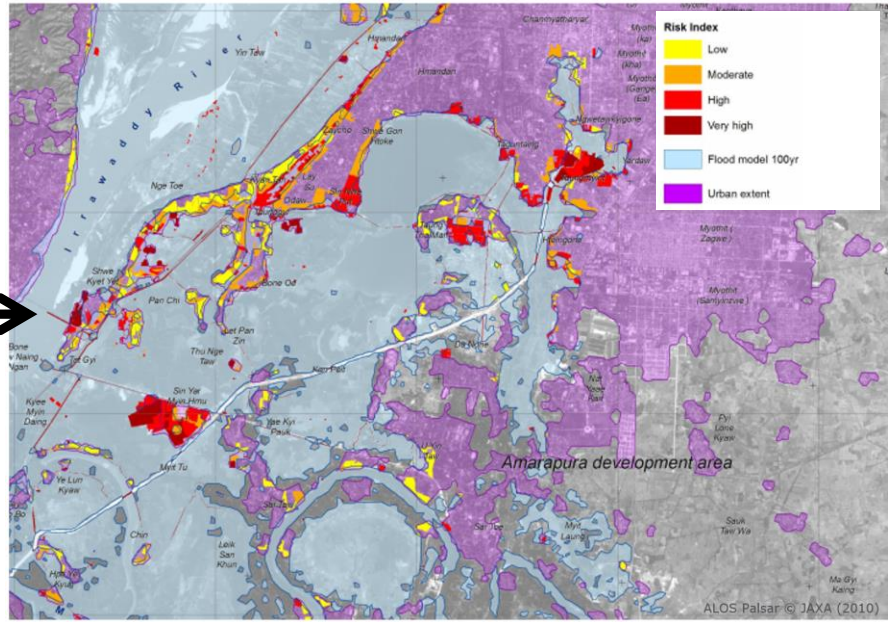
Service 1+2: Urban land use and land use change mapping – Examples



Combining the land cover information from Service 1 with the flood assessment from Service 2

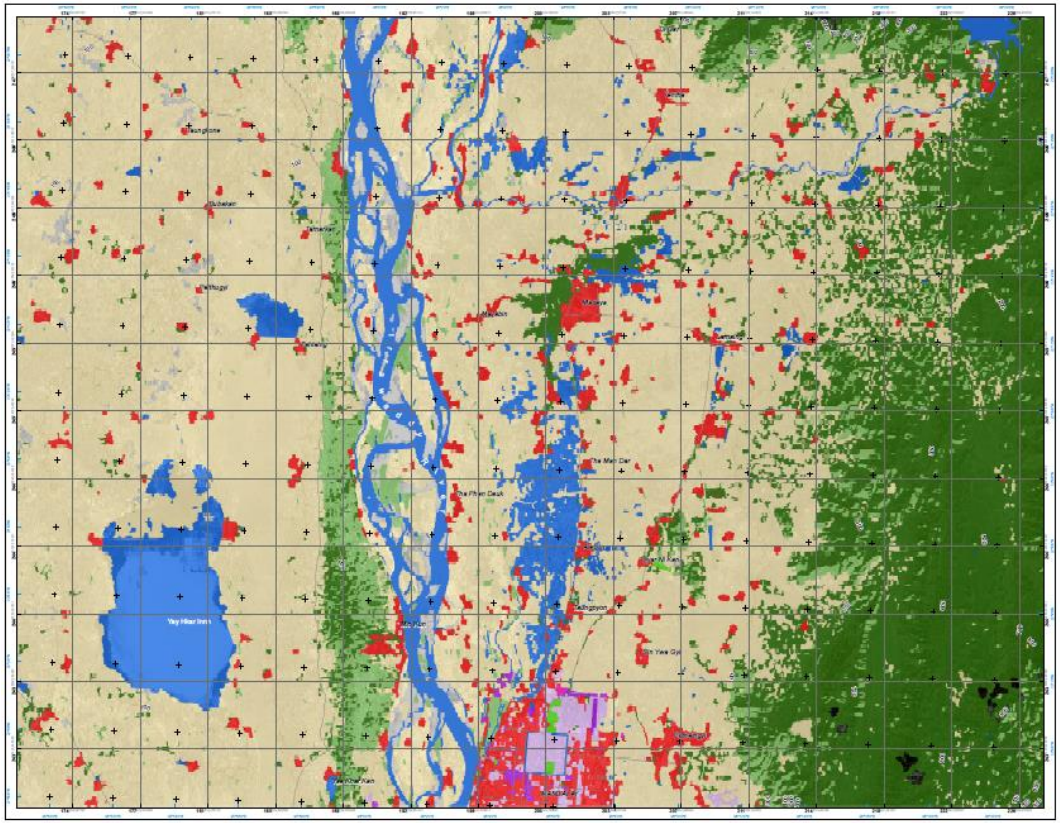


EO based probability + DEM based modelling



Flood risk map

gisat



EOTAP project:
Projekt K: Urban Services Improvement in Myanmar

Contractor(s): GISAT s.r.o. (Czech Republic).

Interpretation: The land cover map shows status of land cover in the Mandalay city area, Myanmar, as of year 2013. High resolution Landsat satellite imagery acquired on 12.12.2013 was used to extract land cover layer on basis of semi-automated object-based image classification and interpretation. Comparison with up-to-date status could provide valuable information on land cover changes in time and identify spatial and temporal trends related to urban extension.

The series of maps aim to support Asian Development Bank activities in Mandalay: urban management, development of urban extension zones, identification of flood hazards and related risk for urban land cover classes.

Image data: Landsat 8 © USGS (2013).

Vector data: © OSM (2015), toponyms © GoogleMaps (2015).

Base map: Landsat 8 © USGS (2013).

- Yay Htar Inn - Water bodies
- The Man Dar - Town
- Roads
- 100m Contour
- Formal residential urban fabric
- Commercial and industrial units
- Non-residential urban fabric
- Urban greenery
- Construction sites
- Agriculture
- Trees
- Other natural and semi-natural areas incl. Wetlands
- Bare land
- Water bodies
- Clouds

EOTAP is a set of twelve projects with the purpose to produce, deliver and assess the benefits of information services based on Earth Observation (EO), in support of ongoing **Asian Development Bank (ADB)** projects. This work is part of the **European Space Agency's** efforts to raise awareness within International Financial Institutions and Multilateral Development Banks of the capabilities of EO to provide information customised to the needs of individual bank projects, with emphasis on using data from European and Canadian EO satellite missions.

Coordinate System: WGS 1984 UTM Zone 47N
Projection: Transverse Mercator
Datum: WGS 1984
false easting: 500 000,0000
false northing: 0,0000
central meridian: 99,0000
scale factor: 0,9996
latitude of origin: 0,0000
Units: Meter

Printed on 23.6.2015

Mapsheet 1
Mapsheet 2
Mapsheet 3

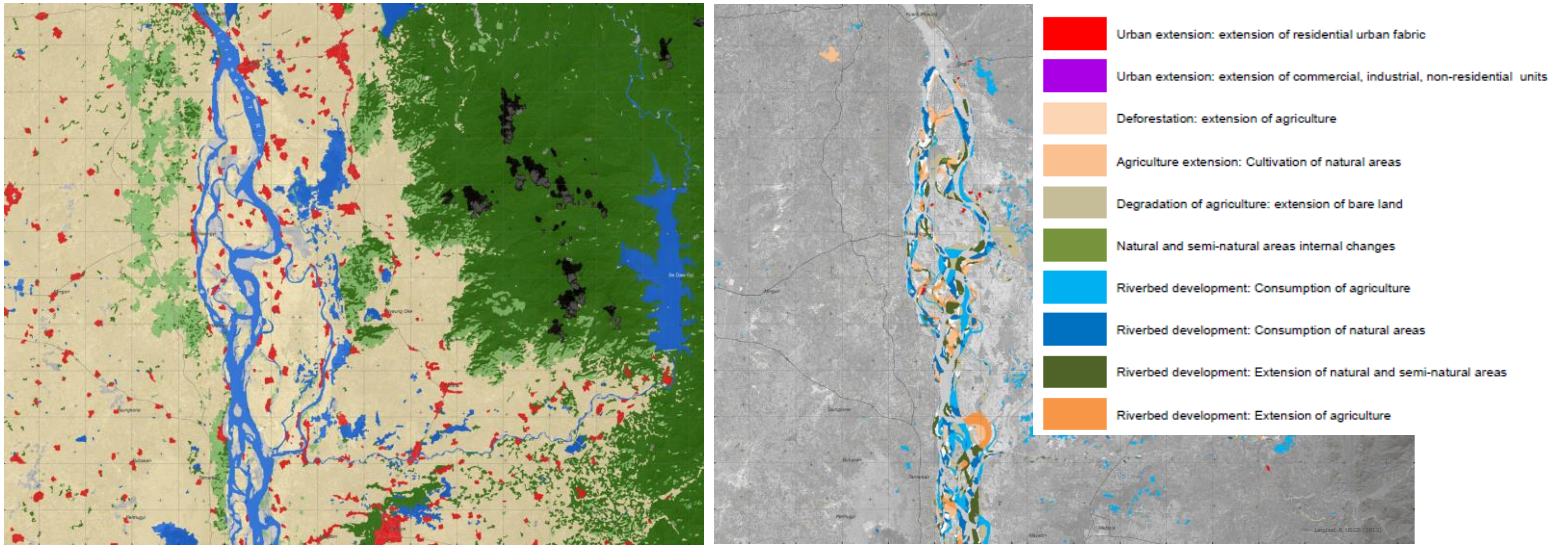
SERVICE 3 - LAND COVER MAP OF MANDALAY AREA , MYANMAR: 2013
Mapsheet 2

1:90 000
1 cm = 900 m

0 0,5 1 2 3 4 5 6 7 8 9 10 11 12 13 km

Service 3: Regional land use and land cover change mapping – Examples

- Medium-resolution land cover status useful for regional-scale analysis
- Changes identifiable at this scale refer mainly to agriculture development, urban expansion or environmental degradation, such as deforestation

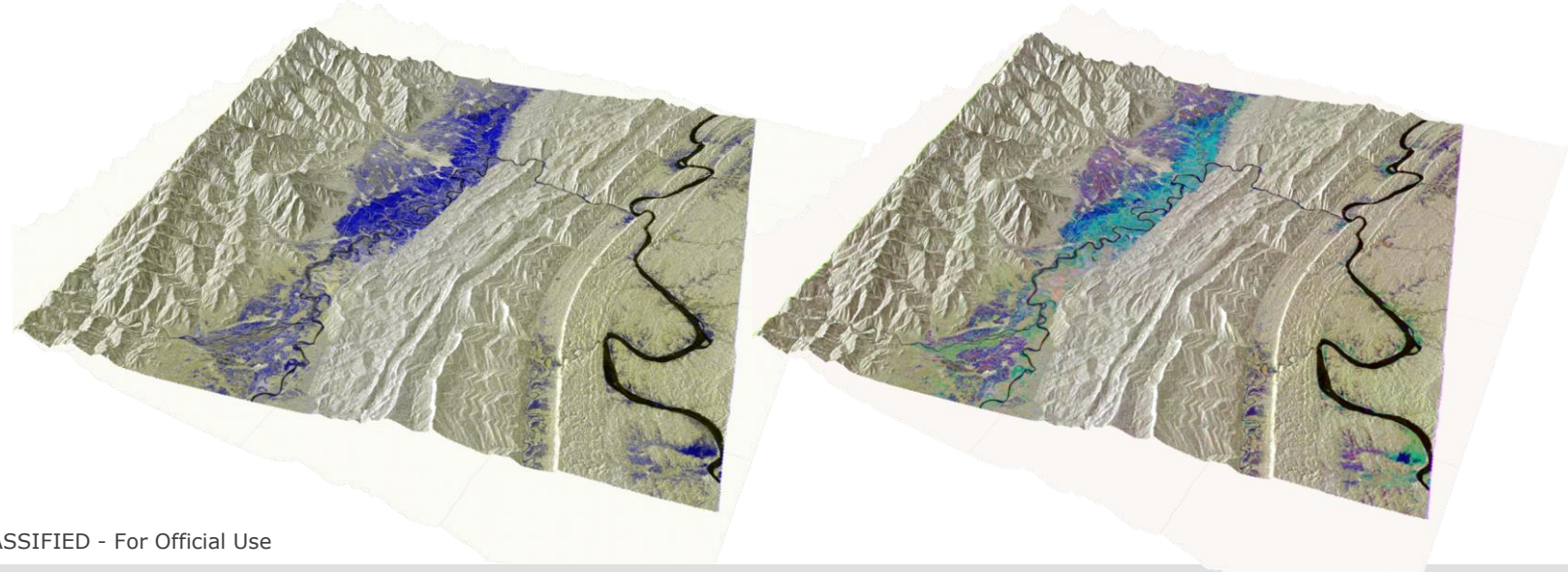


Service 4: On-demand demonstration of rapid flood mapping – Examples

Demonstration of extracting inundation extent and its evolution during 2015 severe monsoon floods using data from the Sentinel-1A satellite

Not affected by cloud cover or rain

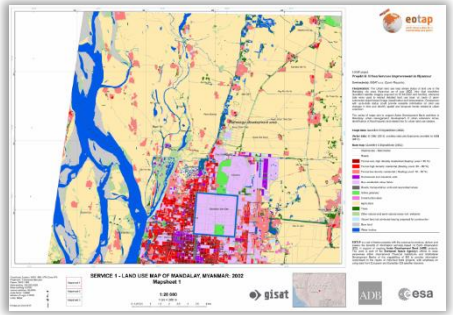
City of Kalay in Kalaymyo district



Service Outputs

Output as **vector and raster datasets** in the most common GIS-ready formats

ESRI Shapefile, ESRI GDB, GeoTIF



Printable maps

- GeoPDF, GeoTIF

Operational Documentation (OD)

Including guidelines to use

Interpretation of results

Detailed products description

Validation results

Capacity Building

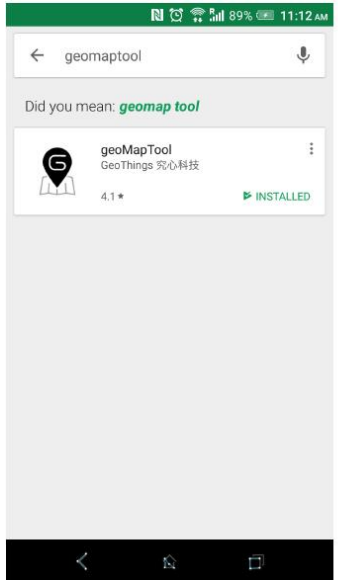
Capacity building workshop in Mandalay

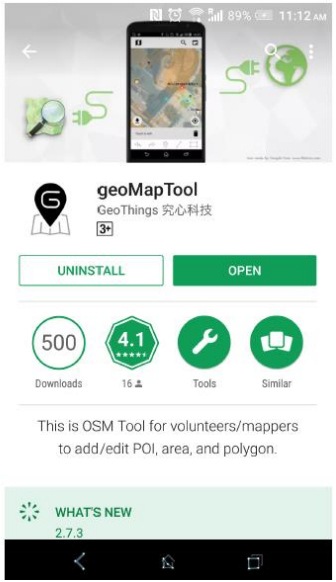
- 2-day training for local stakeholders
- Mandalay Technological University, 2015 September 24–25
- 26 participants (5 institutions, 8 departments)
- offline version of the Data Exploration Tool demonstrated

Ongoing Developments in ADB

SAF (Spatial Data Facility)

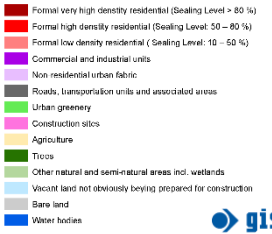
Strengthening Collection of field data involving local communities, to be used for Risk Assessment, Adaptation and Mitigation and city planning in general

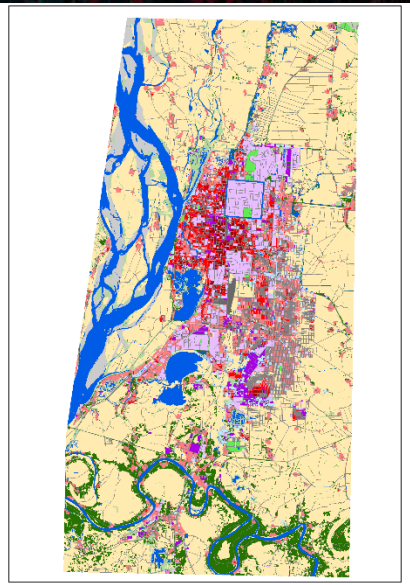


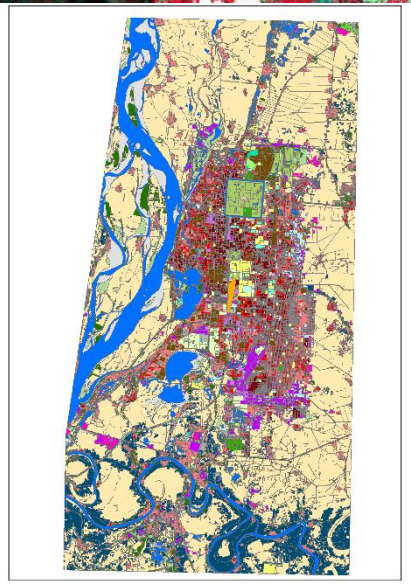


New service: Update/upgrade for 2016

- Update of existing information
  - Land use land cover and change
  - Green and Open areas
  - Informal areas
- End of Phase 1 (9/2017)







Continuation of City work with ESA

urban development
eo4sd

urban development
earth observation for sustainable development

Deliverered in Phase 1

ADB Programme and Cities, Country	EO4SD-Urban Products
Second Integrated Urban Environmental Management in the Tonle Sap Basin Project: Kampong Chhnang, Cambodia Pursat, Cambodia Serei Saophoan, Cambodia Stueng Saen, Cambodia	• Core and Peri-Urban Land Use/ Land Cover & Change • Urban Extent/Imperviousness • Urban Green Areas & Change • Population Distribution and Density & Change • Flood History, Flood Risk & Associated Infrastructure Exposure

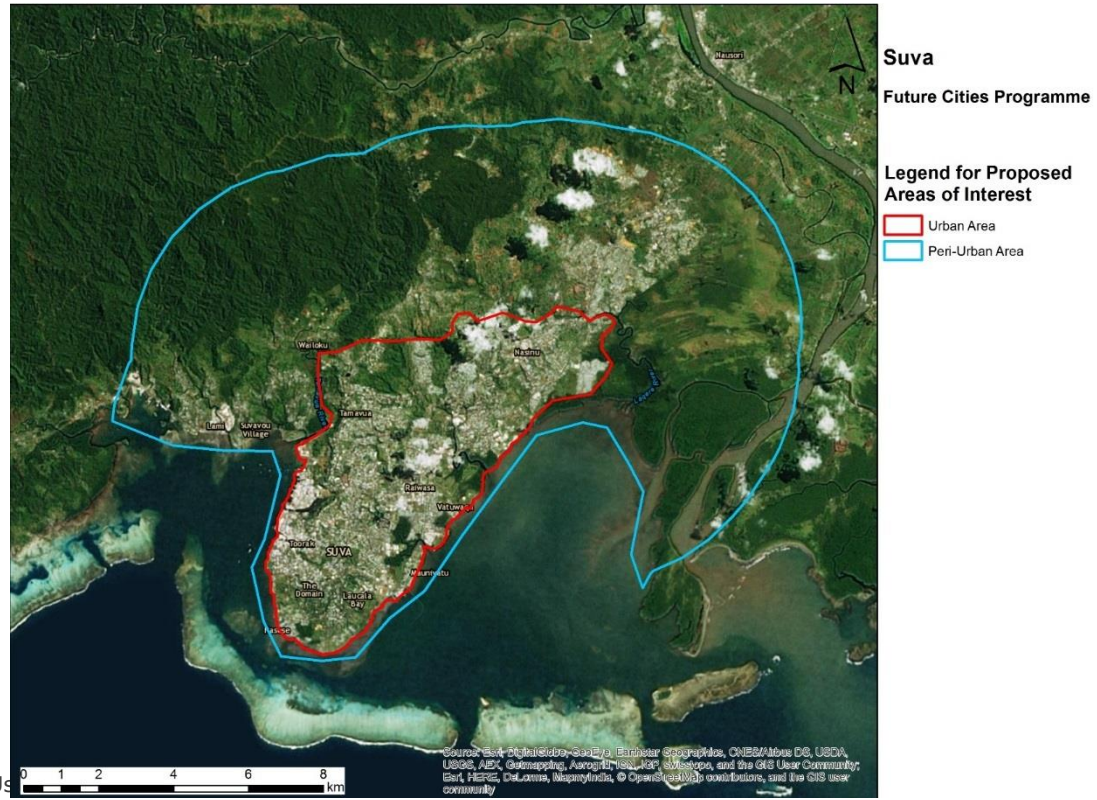
Deliverered in Phase 1

ADB Programme and Cities, Country	EO4SD-Urban Products
Kolkata Environment Improvement Investment Program - Tranche 1: Kolkata, India	• Core and Peri-Urban Land Use/ Land Cover & Change • Peri-Urban Land Use/ Land Cover & Change • Urban Extent/Imperviousness • Urban Green Areas & Change • Extent and Type of Informal Settlements & Change

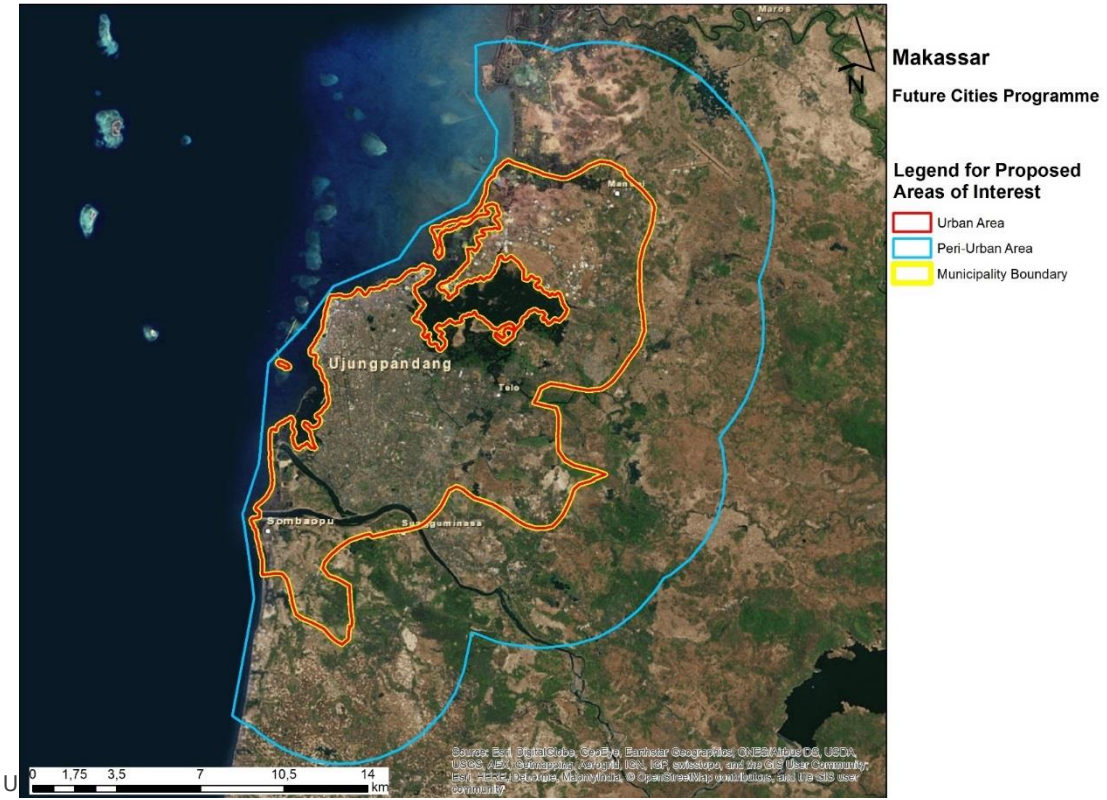
Delivery for Phase 2

ADB Programme and Cities, Country	**EO4SD-Urban Products**
Future Cities Programme: Suva, Fiji Makassar, Indonesia Mandalay, Myanmar	• Core Urban Land Use/ Land Cover and Change • Urban Extent & Imperviousness (DLR product) • Urban Green Areas and Change • Extent and Type of Informal Settlements • Population Distribution and Density • Transport Infrastructure - Road Network

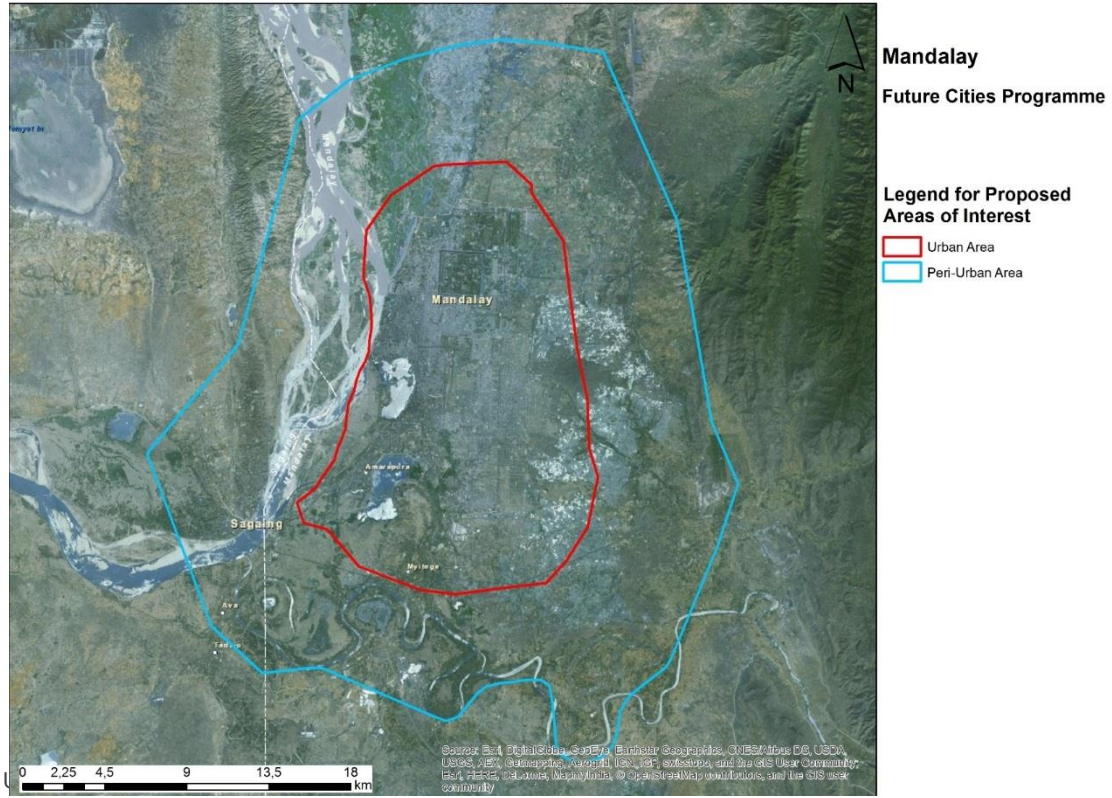
Proposed AoIs for Suva



Proposed AoIs for Makassar



Proposed AoIs for Mandalay



Conclusions

- Earth Observation (EO) offers maps that should be exploited in terms of analytics.
- The consultation and navigation of the information layers is and will happen from your desktop or your mobile (recall SAF).
- EO information layers can be produced with different level of detail-resolution, spatial (meter) and temporal (days) depending where we are in our project cycle.
- ESA supports the use of EO value added products beyond the known platforms.
- And for specific domains: Urban, Agriculture, and Water (Ongoing), Coastal and Marine, Fragile States, DRM and Climate Resilience (starting 2018).

Thank you for your attention!

pmanunta@adb.org

www.esa.int