Communication of Research Results

The IMPETUS Atlas

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Universität zu Köln

MWF NRW

Bundesministerium für Bildung und Forschung

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Introduction: WORKFLOW from Problem to Action

Problem ⇩	Climate change Land use change Hydrologic conditions..
Data ⇩	Measurement data Satellite sata Socio economic data….
Information ⇩	Spatial- / temporal patterns of changes, Indices….
Understanding ⇩	Process dynamics Actors Motivation …
Action	Political measures Technical measures …

State of distribution of data, information and results

- **In scientific projects often comprehensive data collected and important results are gained.**
- **Some of the results are published in scientific papers**
  - **Expensive, not available in the host countries**
  - **Only for experts**
  - **Only brief selection of data published**
- **Problem to communicate the outcomes to stakeholders and other interested people especially in the host countries**
- **After the end of the projects often a lot of the data and their metadata as well as some of the results is lost**

Question:

How to communicate and distribute research results and base information?

During the project:

- Discussing preliminary results
- Deriving process understanding
- Distributing the data
- Validation

After project

- Compile all data, methods, results
- Store metadata (information about the collection and processing)
- Make data available

Distribution of data, information and results within the IMPETUS Project

- Website (*www.impetus.uni-koeln.de*)
- Geo-data-base in www
- External hard disk drives with all data and results for partner institutions
- IMPETUS ATLAS

One Solution for distributing science results

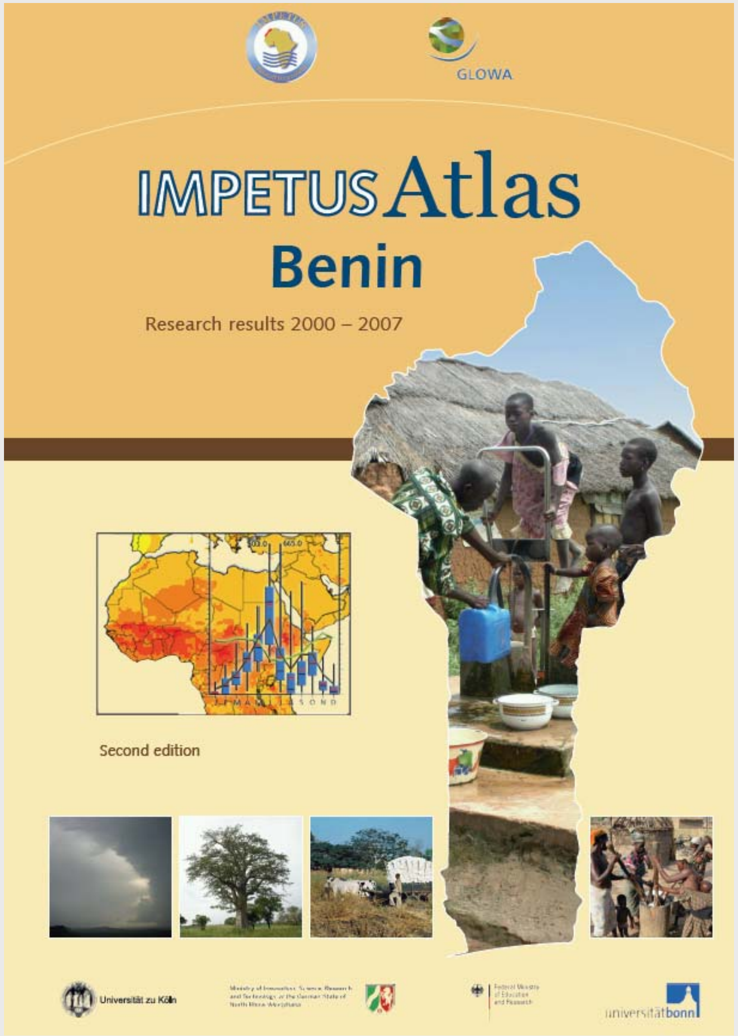
The IMPETUS ATLAS

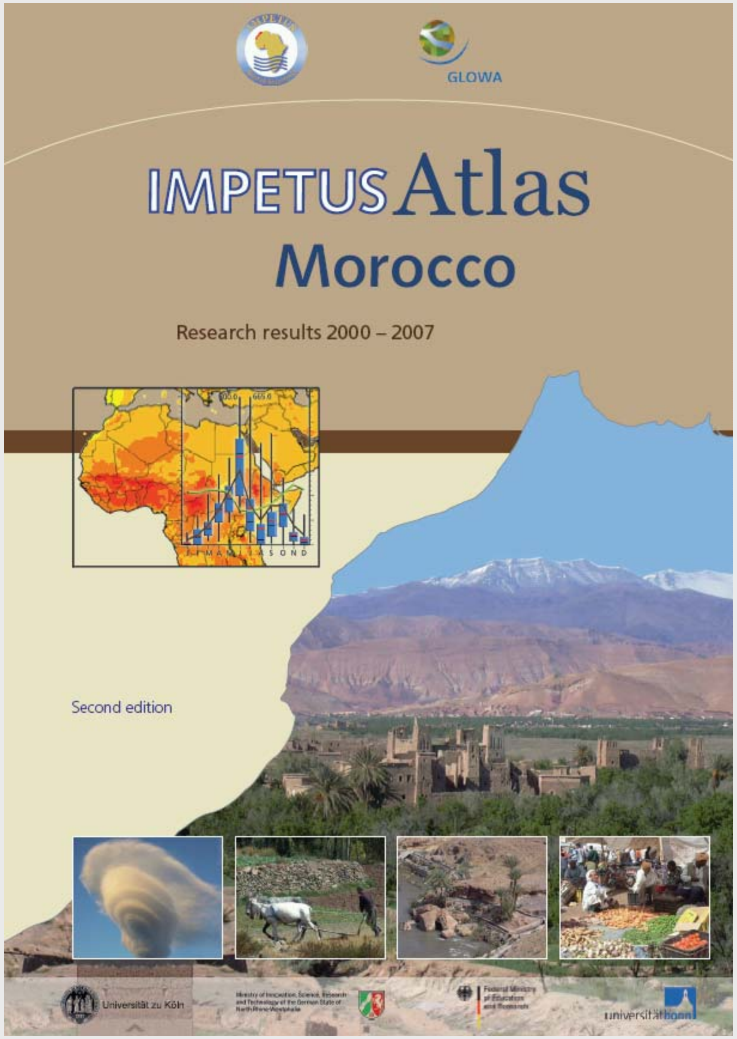
Printed Version

Interactive IMPTEUS Digital Atlas (*IIDA*)

The IMPETUS ATLAS

Printed version A4 Soft cover





The IMPETUS ATLAS

Printed version

- Comprehensive compilation of relevant topics on 2 pages
- Relevant maps
- Graphs and photos
- Text scientific sound but understandable for laymen
- Continuative references

➡ Handy reference to get a sound overview

Example of the IMPETUS ATLAS: Printed version

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Spatial and Temporal Rainfall Climatologies of Benin

Andreas H. Fink, Susan Pohle and Ralf Hoffmann

Based on the mean total annual rainfall, rainfall evolution during the rainy season, and the occurrence of rainfall during the course of the day, Benin can be divided into distinct rainfall regions.

Methodology

The 93 available rainfall stations in Benin experienced data gaps in their daily rainfall records in the climate normal period from 1961 to 1990. Of the 42 stations that entered the present study, each met the following criteria: (a) the number of missing values was under 10 % for a given year, and (b) more than 80 percent of the annual rainfall totals were available for the period from 1961 to 1990.

The likelihood of rainfall during the day at six synoptic weather stations in Benin was calculated as the percentage of rainfall occurrence during the 96 15-minute intervals between 00 and 24 UTC for the 29-year period from 1962 to 1990.

Mean annual rainfall

The map of the mean annual rainfall (Fig. 1, right panel) over Benin shows several striking features. Firstly, a west-east gradient is observed along the coastal strip, with the highest national rainfall amounts near the Nigerian frontier (Seme: 1485 mm) and a dry zone with less than 1000mm near the Togolese frontier. The latter represents the north-eastern tip of the coastal Ghana-Togo dry zone (Vollmert et al., 2003). Secondly, higher rainfall amounts in the Beninese parts of the Togo-Atakora low mountain range (Djougou: 1309mm) are also evident. Finally, the map indicates the strong northward rainfall decrease north of 10° 30′ N, with the driest national station being Malanville (787 mm).

At least three seasonal rainfall regimes (Fig. 1, left panel) are found in Benin. These include: (a) a bi-modal rainfall distribution between the coast and 7° 30′ N, with the first rainy season being more intense (e. g. Cotonou and Sakete), (b) a broad peak with indications of either a weak tri- or bi-modal distribution at some stations in central Benin (e.g. Savè and Parakou), and (c) a clear uni-modal signal characterized by a slow increase in rainfall and a sudden decrease (e. g. Kandi) (Adam and Boko, 1993).

Diurnal rainfall

Like in other parts of West Africa, the diurnal peak of rainfall probability varies across Benin depending on the distance of a given station to the ocean and major tropographic features. For example, the inland propagation of the land-sea breeze circulation in the course of the day causes a morning maximum at Cotonou, and a pronounced afternoon maximum at Bohicon (Fig. 2). Another example is the primary or secondary probability peak after midnight at the northern stations at Parakou, Kandi and Natitingou (Fig. 2). At this time of day, large thunderstorm clusters, which were generated in the late afternoon over the central Nigerian highlands, then propagate westward at about a constant speed of 50 km h⁻¹, arrive over north-central Benin (Fink et al., 2006).

Acknowledgements

We are grateful to C. Depraetere and J.-M. Bouchez from the Institute de Recherche pour le Development (IRD), as well as to the National Weather Service (DMN) for providing us with the rainfall data.

References

Adam K. S. and Boko, M. (1993): Le Climat du Benin. Les Editions du Flamboyant/EDICEF, Cotonou/Benin. Le Benin, 15–18.

Fink, A. H., Vincent, D. G. and Ermert, V. (2006): Rainfall Types in the West African Soudanian Zone during the Summer Monsoon 2002. Mon. Wea. Rev., 134 (8), 2143–2164.

Le Barbé, L., Lebel, T. and Tapsoba, D. (2002): Rainfall Variability in West Africa during years 1950–1990. J. Climate 5 (1), 187–202.

Vollmert, P., Fink, A. H. and Besler, H. (2003): Ghana- und Dahomey-Trockenzone: Ursachen für eine Niederschlagsanomalie im tropischen Westafrika (in German). Erde, 134 (4), 375–393.

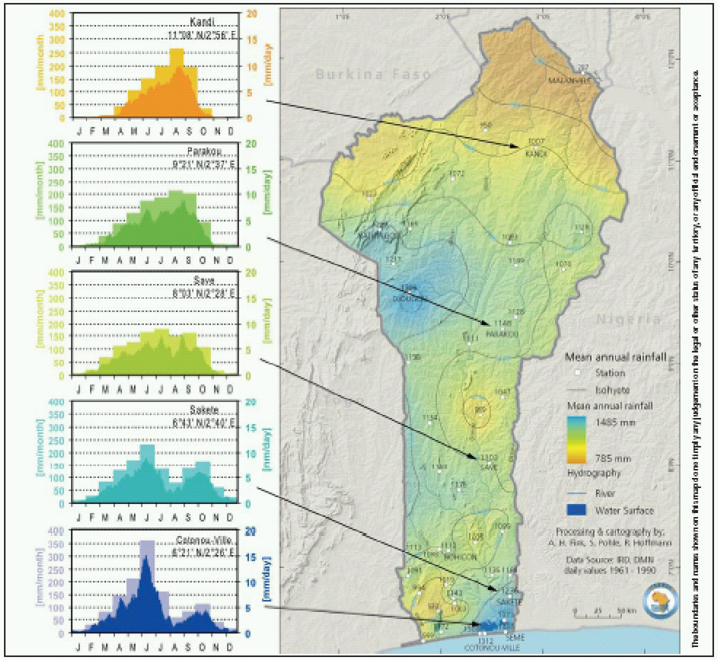

Fig. 1: Mean (1961–1990) monthly rainfall amounts (left abscissa) and daily rainfall (right abscissa) expressed as the 11-day running mean of the 1961–1990 mean daily rainfall for selected stations (left). Map of mean annual rainfall (in mm) for the period from 1961 to 1990 (right).

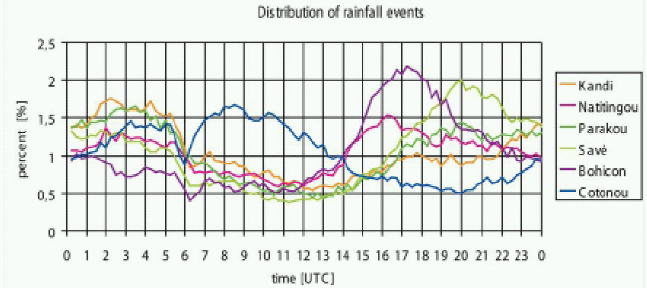

Fig. 2: The diurnal cycle of rainfall probability expressed in percent for 15-minute intervals between 0 and 24 UTC for the period 1962 to 1990 (1961 missing).

Example of the IMPETUS ATLAS: Printed version

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Land Use Dynamics in Central Benin

Michael Judex, Hans-Peter Thamm and Gunter Menz

In central Benin, strong land cover and land use changes (LUCC) can be observed due to rapid population growth and expansion of agricultural areas. To investigate these changes, land cover and land use information for different time periods were obtained from satellite images and compared. The analysis highlights intra-annual vegetation dynamics as well the locations and amounts of anthropogenic land use changes.

Data used

To obtain and explain information on land use/land cover changes, observations from different time periods are required. In addition to land cover data from the year 2000 (acquisition date: 26th October, see preceding page), satellite data from 1991 (acquisition date: 13th December) were classified into the same land use categories.

Changes in land use

A comparison of the years 1991 and 2000 shows very strong changes (see Tab. 1). An increase in agricultural areas and settlements is obvious. *Communes* with high absolute population growth, like Tchaourou and Djougou, display an increase in agricultural area of 36 % and 40 %, respectively. In addition, the vegetation reveals strong intra-annual vegetation dynamics. This is due to strong phenological change in the course of the wet and dry seasons. With the onset of the dry season, grass vegetation becomes dry and many trees lose their leaves, a prerequisite for the widespread bush fires that affected 35 % of the area of the Upper Ouémé in 1991 (until 13th December). Figure 1 shows examples of these changes in LANDSAT satellite images. These effects make it difficult to derive the same vegetation patterns (and areas) from satellite images taken at different dates and seasons.

Some vegetation units, like gallery forests, change their shape, and their contrast to the neighbourhood vegetation is altered. Other vegetation types, like bush or wood savannah, are affected by bush fires and are no longer distinguishable. These circumstances are important when interpreting Tab. 1.

Regional dynamics

Land use changes show different dynamics in different regions. Figure 2 (map A) displays the increase in agricultural area per *Arrondissement*. In every *Arrondissement*, the agricultural area is increasing, but at different rates. High rates of change are generally found either in regions with high population growth (e.g., Donga) or in regions with large available land resources (e.g., Bassila).

The expansion of agricultural areas occurs mainly at the expense of savannah or forest areas. To detect hot-spots of such deforestation, a pixel-by-pixel analysis was performed, with results shown in Fig. 2 map B. In densely populated areas like Ouaké or Copargo, the fraction of new agricultural area established by deforestation is very low, as very few forest areas remain for conversion. In these areas, a typical bush-fallow rotation system is found (Judex, 2008). In contrast, high deforestation activities are found at the forest borders relatively far from larger towns. Especially high deforestation activity can

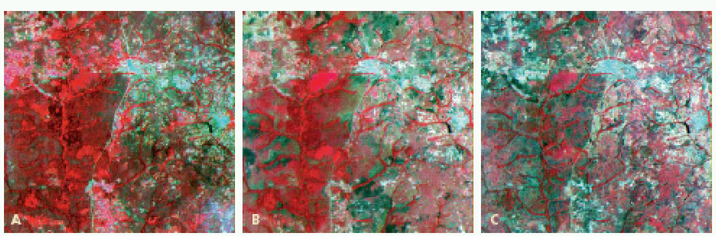


Fig. 1: Example of intra-annual vegetation dynamics in the region of Bassila. LANDSAT false-colour images from A) October; B) December; C) March. Green vegetation is in red and burned areas in dark green.

Tab. 1: Land-use changes from 1991 to 2000 in hectare for some Communes in central Benin.

	Tchaourou		N'Dali		Bassila		Djougou	
	1991	2000	1991	2000	1991	2000	1991	2000
Forest & dense Savannah	351,219	431,782	221,881	225,521	377,605	431,917	100,955	99,625
Savannah	54,965	159,293	37,391	119,470	23,213	116,089	71,270	213,653
Settlement	139	424	106	289	68	135	237	672
Agricultural area	38,838	60,452	24,046	30,363	16,843	23,918	47,706	79,483
Burned area	208,603	0	92,595	0	154,793	0	173,403	0

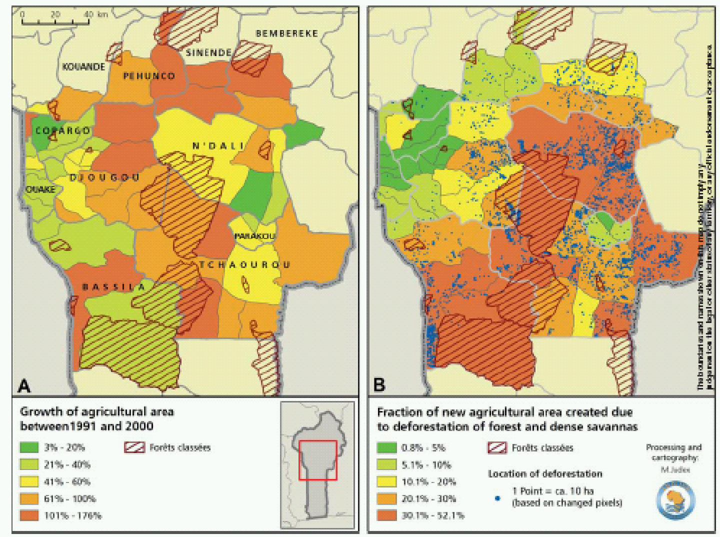


Fig. 2: Land-use dynamics due to expansion of agricultural areas. Data derived from LANDSAT images from 13.12.1991 and 26.10.2000. The areas of the protected forest are included in the given statistics.

be observed around the *Forêt Classée de l'Ouémé Supérieure*, but the protected area is largely respected except for one location at its western border. This analysis demonstrates the high rates of land use and land cover changes in the area as well the capabilities of remote sensing techniques to capture these dynamics.

References

Judex (2008): Modellierung der Landnutzungsdynamik in Zentralbenin mit dem XULU-Framwork. PhD-thesis, University of Bonn.

Motivation to create a Digital Atlas

- Wide distribution – cheap
- Unlimited content
- Distribution of digital data
- Dynamic content, integration new data and results
- Information layers can be overlaid - understanding
- Creation of own maps

Interactive Digital IMPETUS Atlas:

Technical Realisation

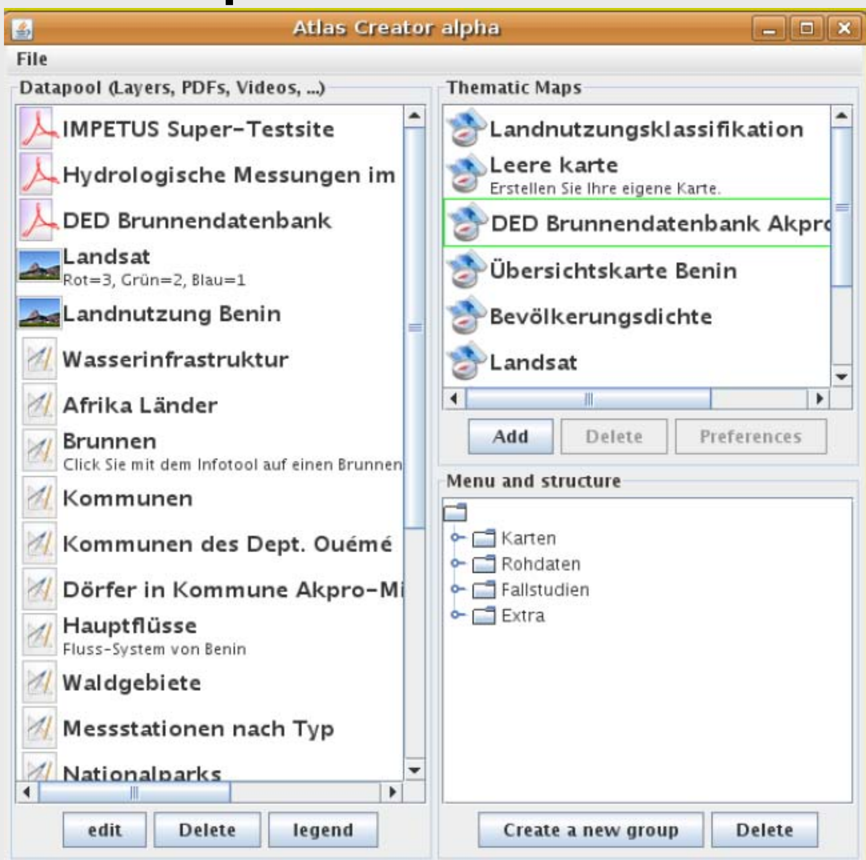
- Programmed in JAVA, independent of a certain computer platform (Windows, Linux, Mac, …)
- "Stand alone" software, no access to internet needed
- Free software, can be distributed without limitation
- To run the Atlas no additional program installation is necessary (only JAVA runtime).
- It is easy to add additional data or to customize the appearance.
- Handles raster images, vector data (e.g. shape files) PDF or HTML format. Displaying of Videos is possible
- Easy integration in the Word Wide Web

Integration of data in the Atlas:

Atlas Creator

Atlas Viewer

Integration of data with drag and drop



Conclusions

- IMPETUS distributes the data and results in adapted ways
- The IMPETUS Atlas concept is an appropriate approach to communicate science results to wide public
- Quick and easy to handle
- Very useful tool
- Very good for process understanding
- Free ware - wide distribution
- Can be applied for other projects as well

Thank you for the attention ***– If you want to know more please approach us at the exhibition***

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The IMPETUS Atlas

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and more than 70 project members and stakeholder

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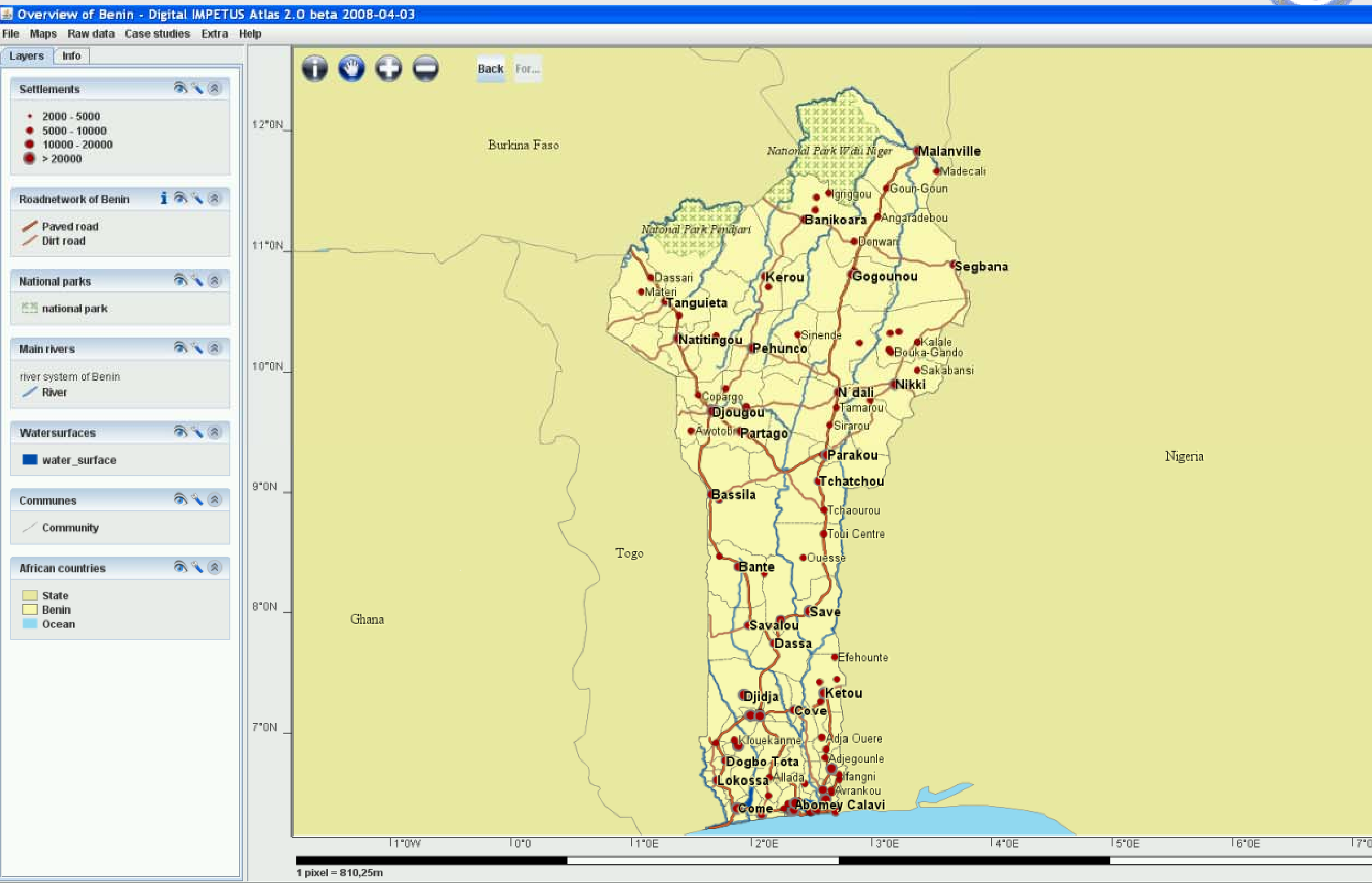
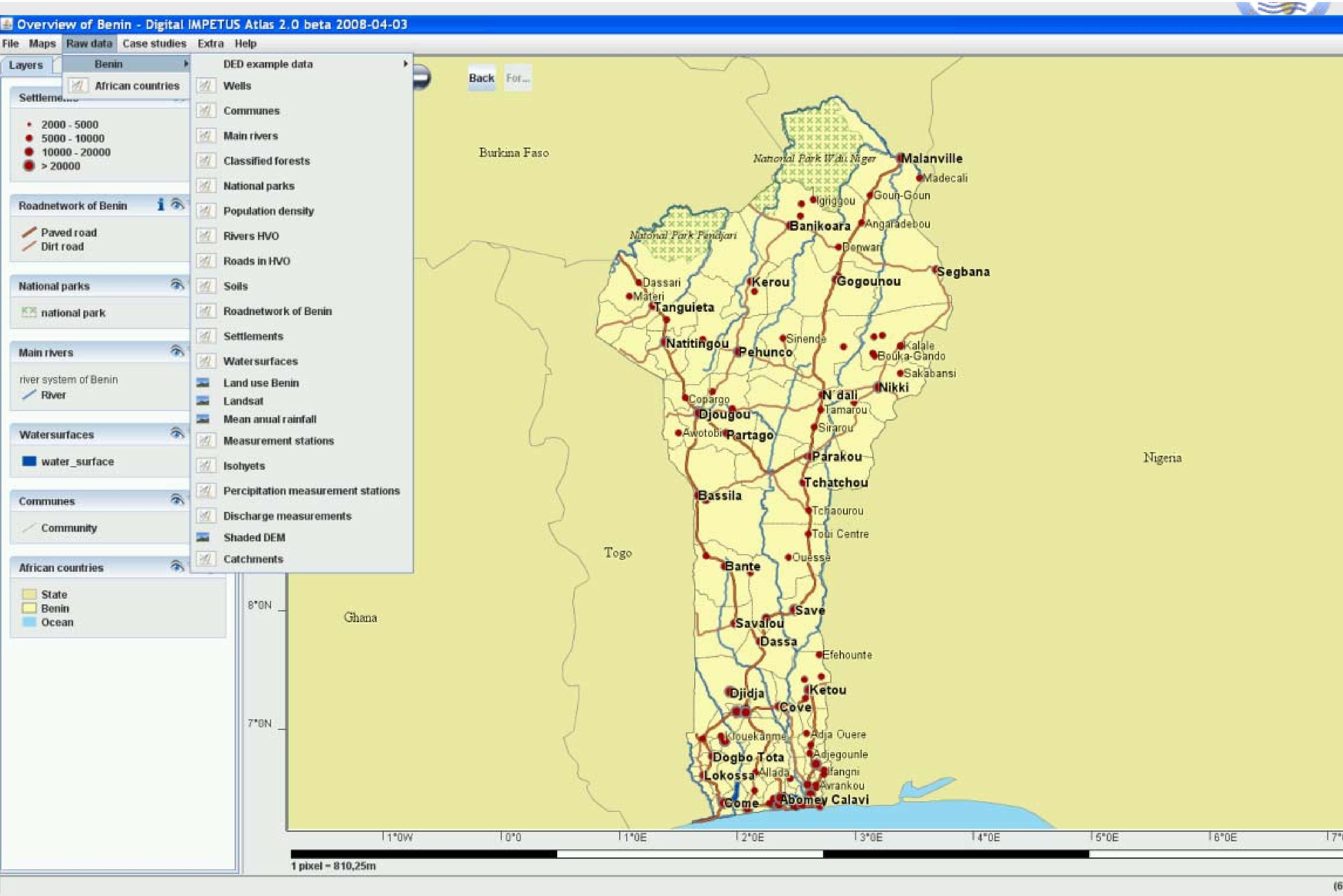
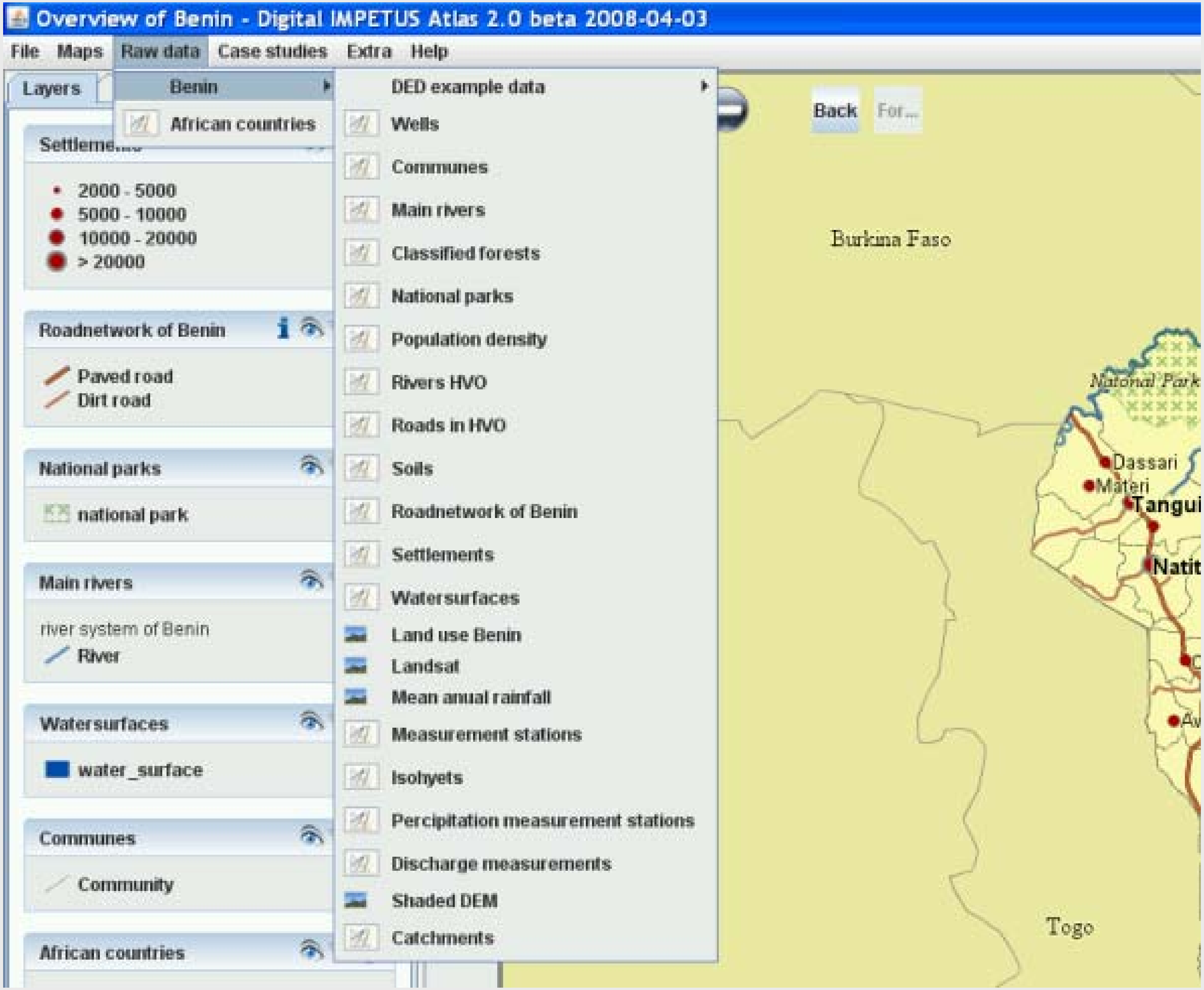
IIDIA: Overview



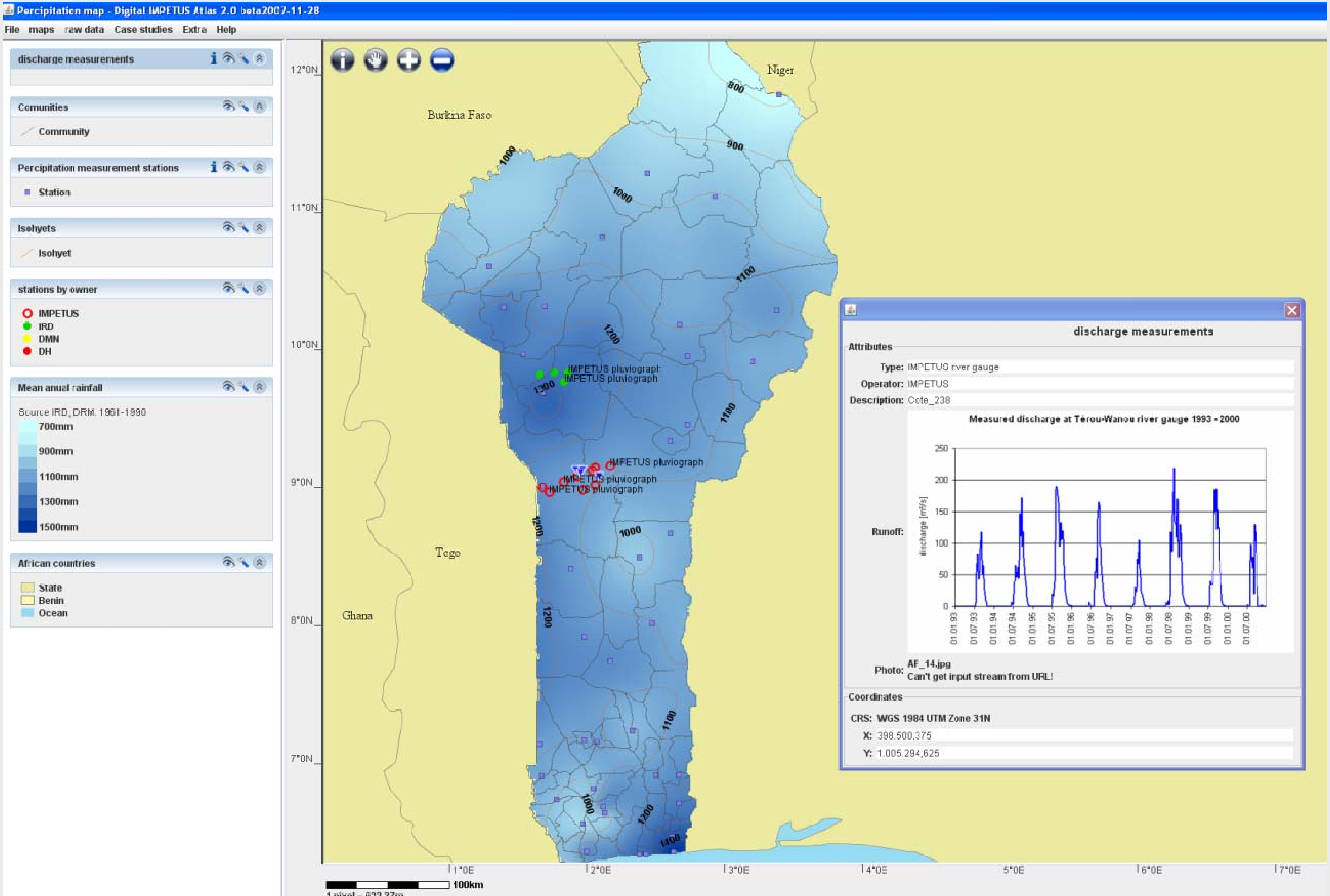
Data: Overview



Data: Landsat-Mosaic Benin



Example


Percipitation map - Digital IMPETUS Atlas 2.0 beta2007-11-28
File maps raw data Case studies Extra Help
discharge measurements
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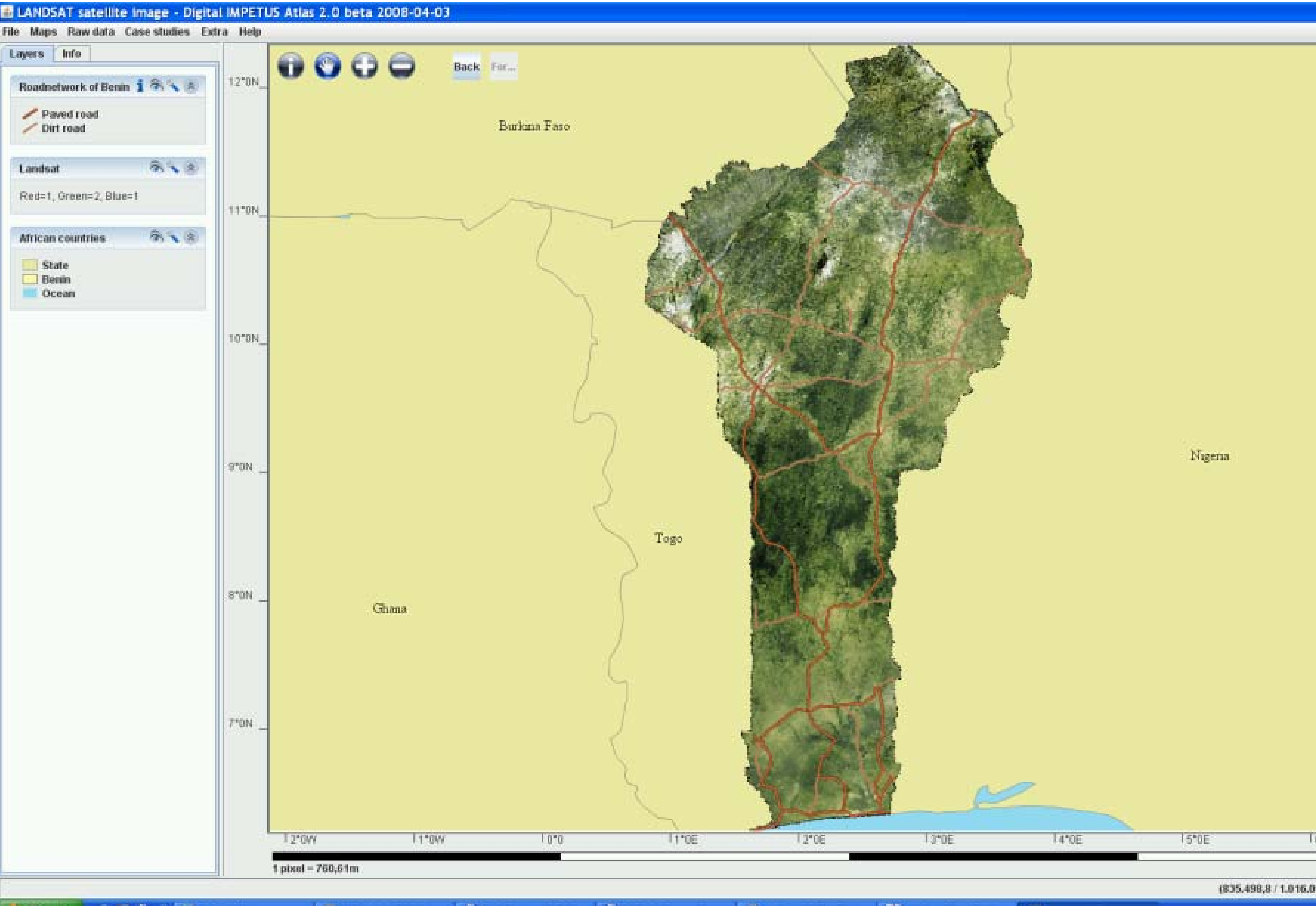
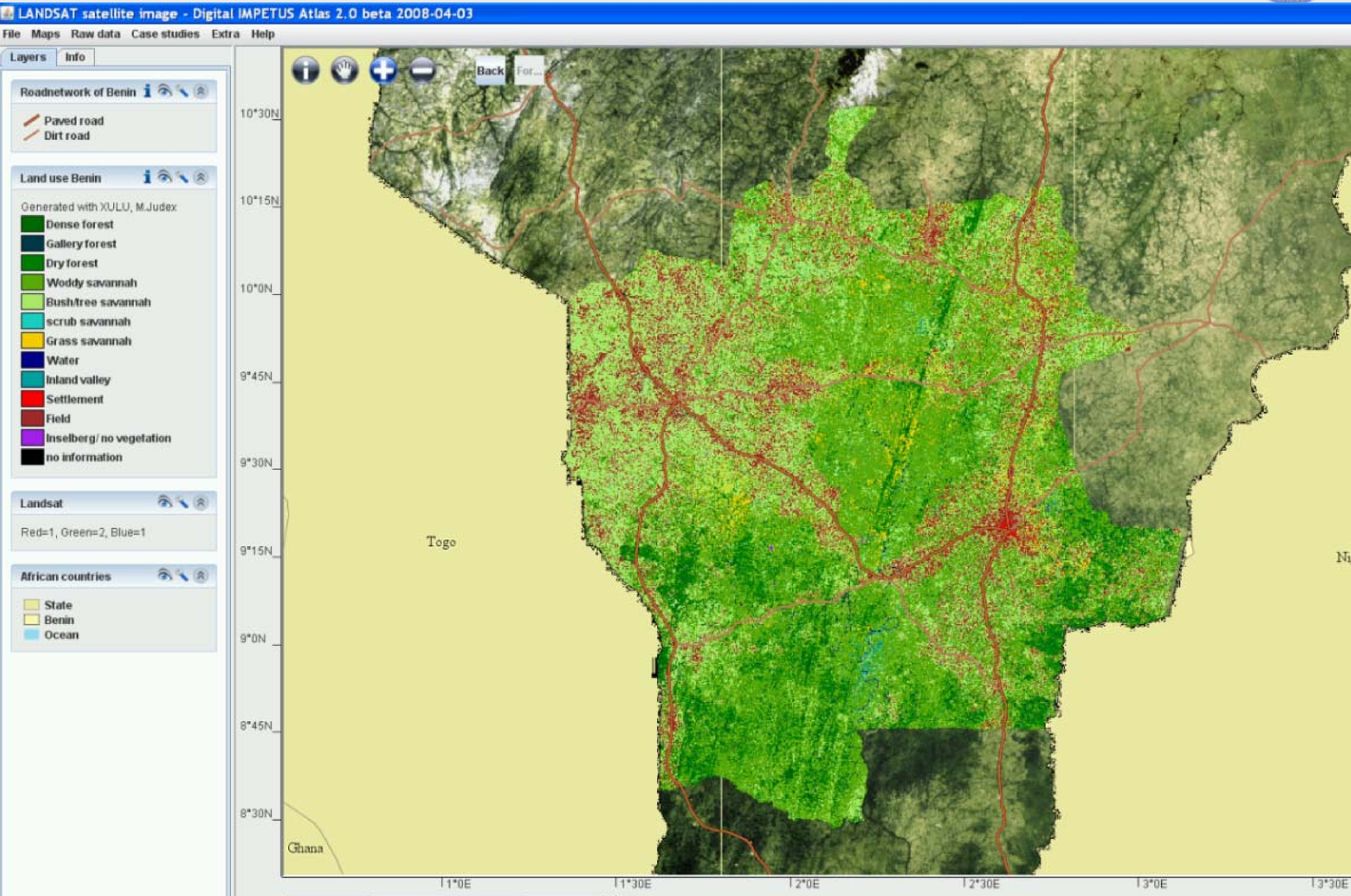
Operator: IMPETUS
Description: Cote_238
Measured discharge at Térou-Wanou river gauge 1993 - 2000
Runoff:
discharge [m³/s]
Photo: AF_14.jpg
Can't get input stream from URL!
Coordinates
CRS: WGS 1984 UTM Zone 31N
X: 398.500,375
Y: 1.005.294,625

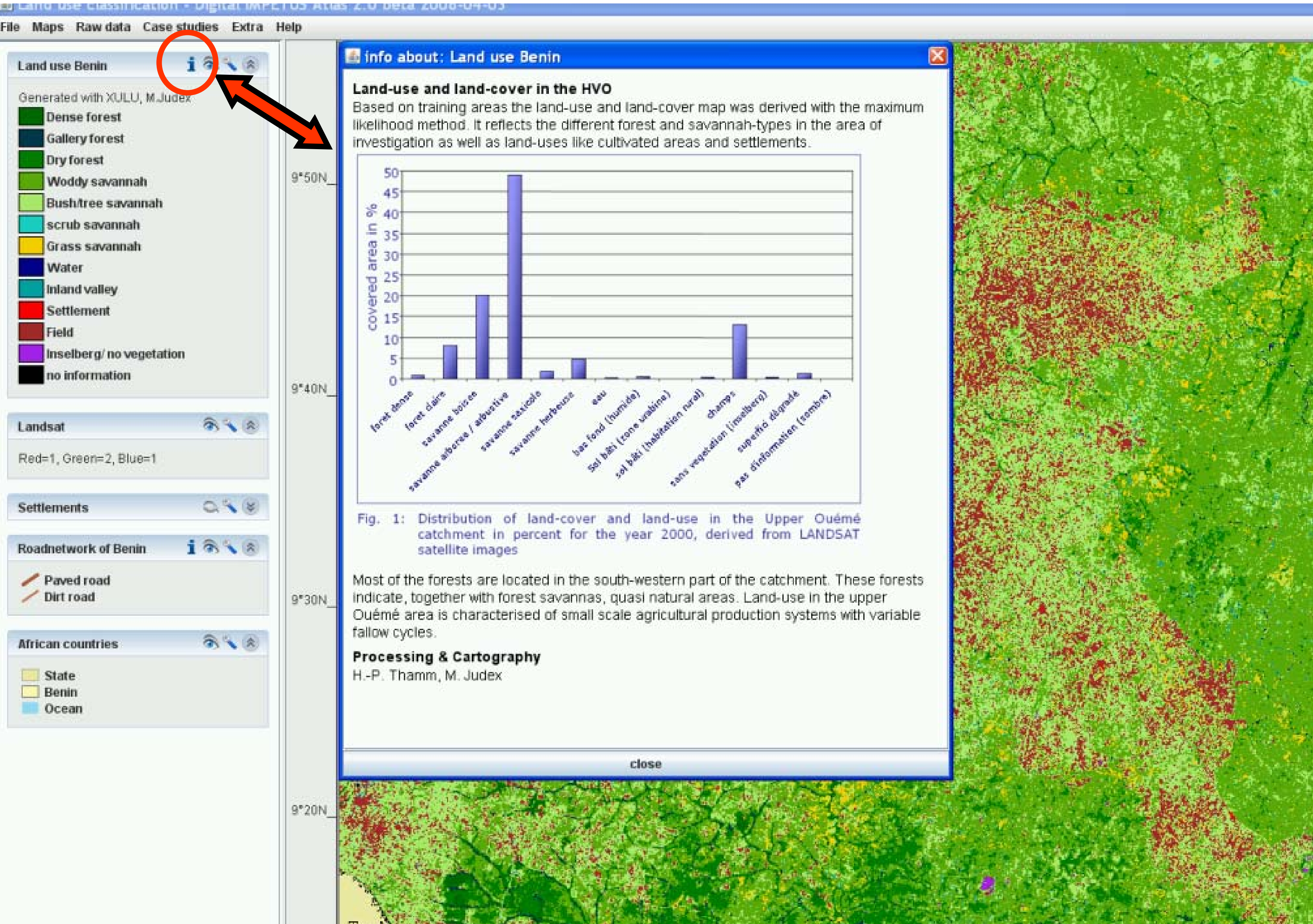
Data: Landsat-Mosaic Benin



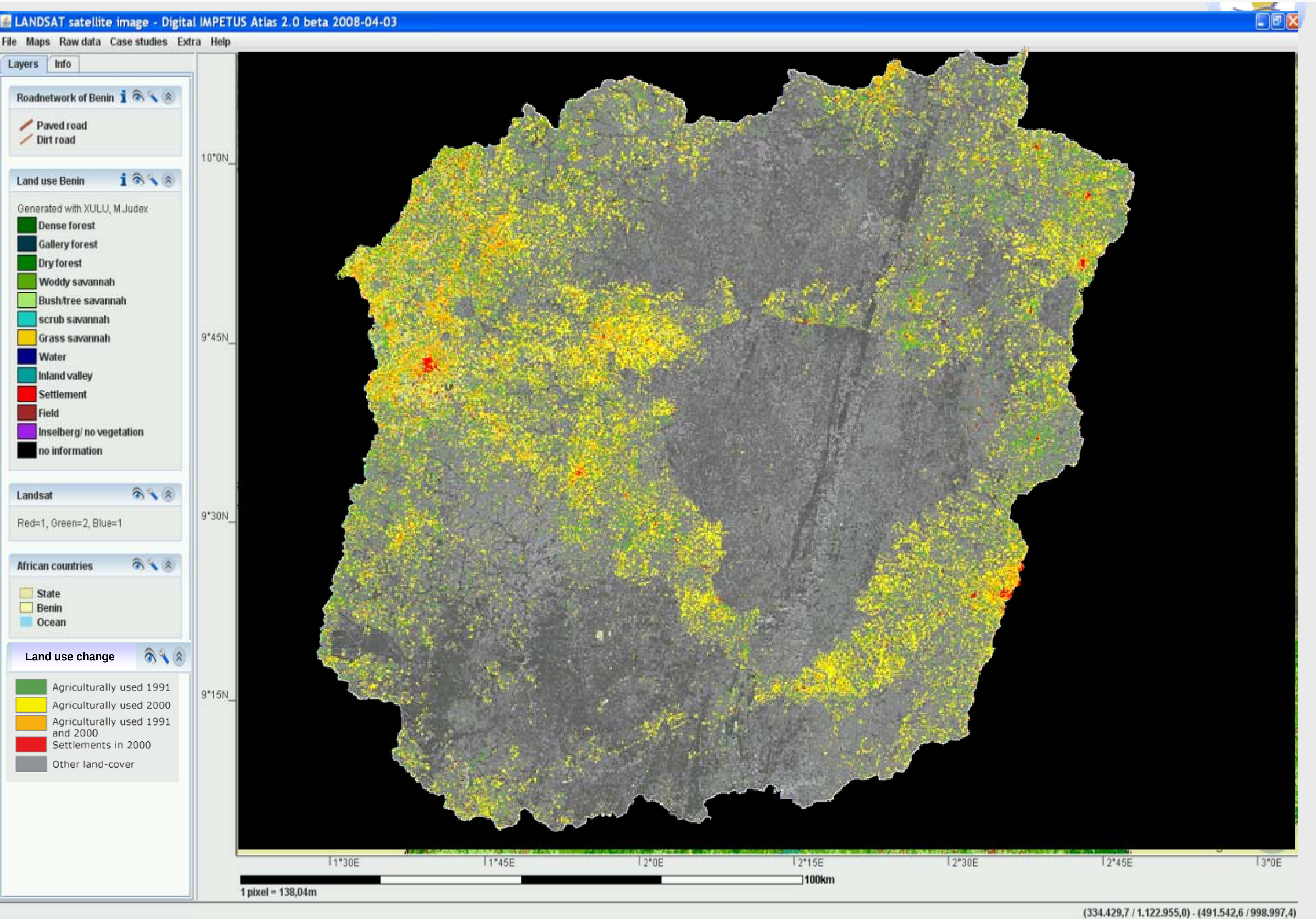
Information: Classification



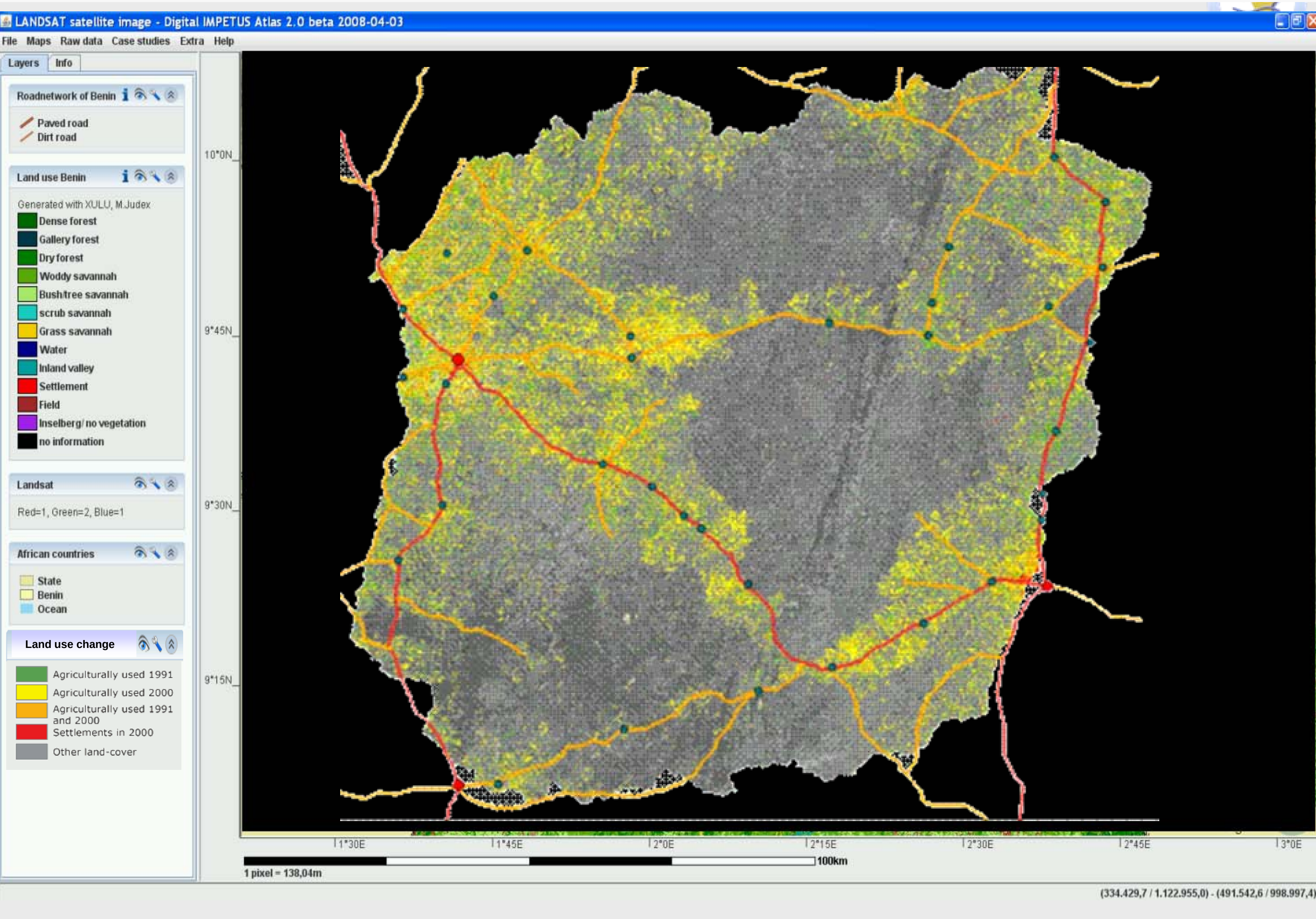
Information: Classification with Metadata



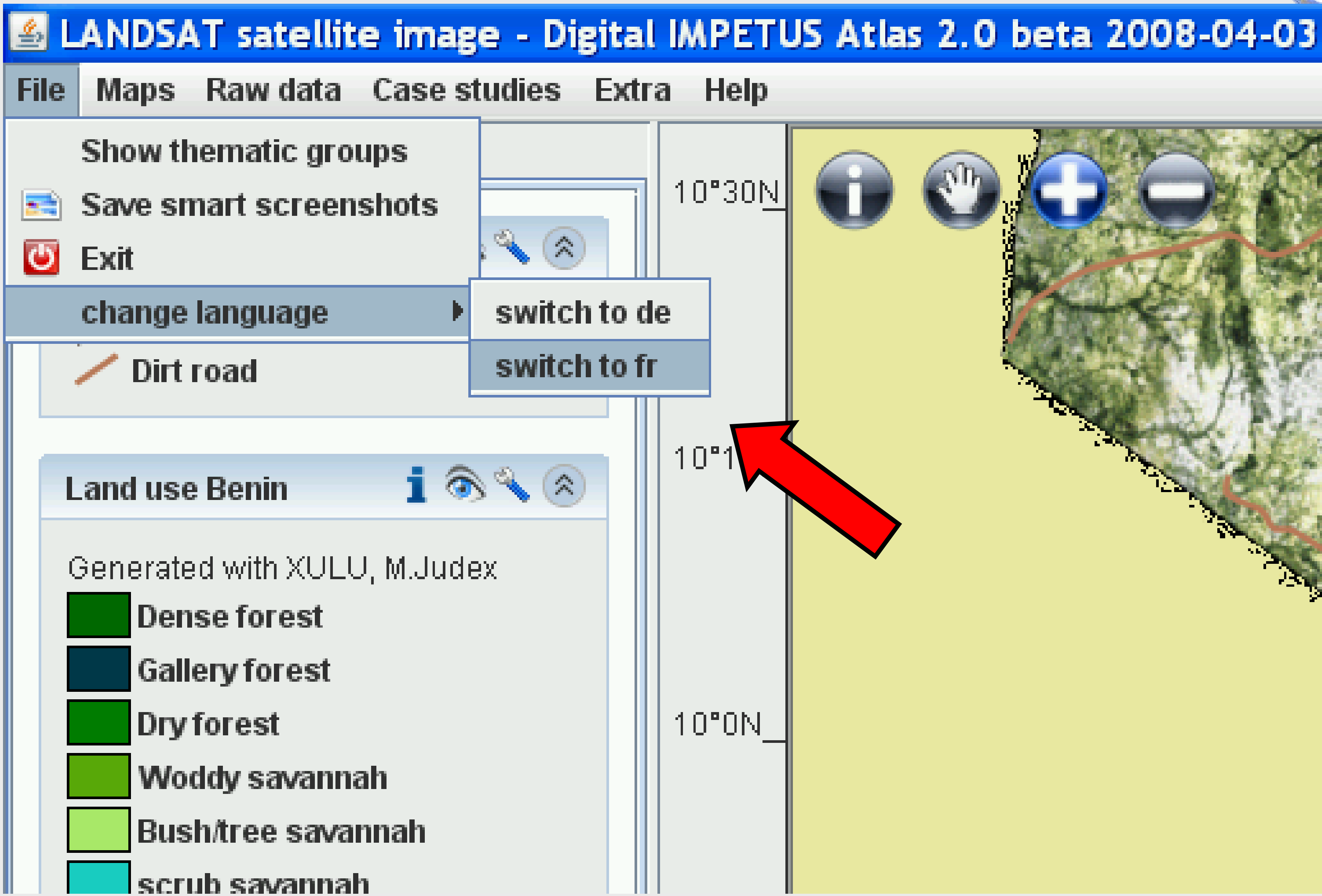
Information: Displaying the changes



Understanding: By overlaying additional Info



Different Languages can be choosen



Example of the IMPETUS ATLAS: Printed version

16 Assessing the Impact of Climate and Land Use Change on Future Water Availability in the Ouémé catchment

Simone Giertz

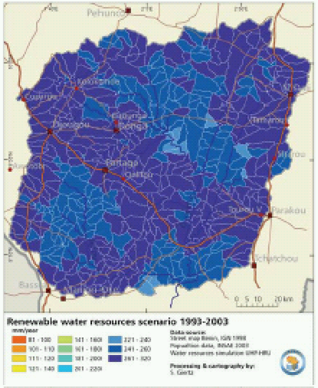
After a successful validation, the hydrological model UHP-HRU was used to simulate different climate and land use scenarios for the Upper Ouémé catchment. For the Ouémé-Bonou catchment, only climate scenarios were simulated as no land use change scenarios were available.

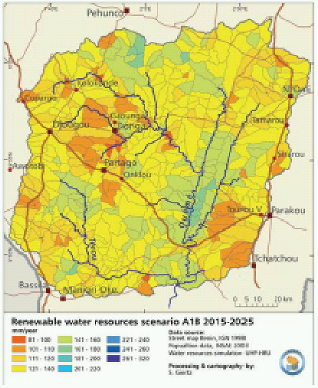
Scenario modelling approach

To assess the effects of climate and land use change on future water resources in the Ouémé catchment, we used an interdisciplinary modelling approach (Giertz et al., 2006).

In the scenario modelling process, the time variant input parameters are computed with other models. LUCC (land use and cover change) modelling is performed with the model CLUE-S (↗40). The climate scenarios are simulated with the regional climate model REMO on a 55km grid. The model is nested into the General Circulation Model (GCM) ECHAM. In order to use the REMO results for hydrological modelling, we applied a statistical downscaling approach for rainfall data.

IPCC climate scenarios A1B and B1 were available. Scenario A1B describes a more globalized world with high economic growth, while scenario B1 is characterized by more sustainable growth.





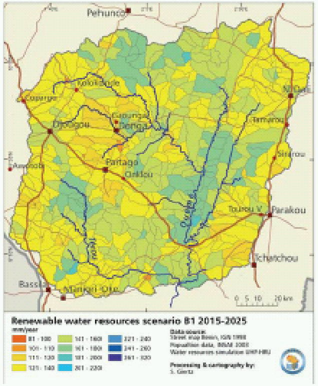


Fig. 1: Comparison of renewable water resources as calculated for 1993–2003 (above) and for climate scenarios A1B (left) and B1 (right) combined with a land use scenario business as usual 2015–2025.

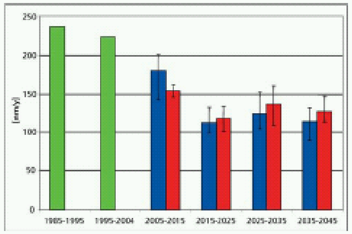


Fig. 2: Renewable water resources in the Ouémé-Bonou catchment for different decades, past (green) and future scenarios A1B (blue) and B1 (red).

For each scenario three ensemble runs were carried out with REMO. In order to take into account the variability of the REMO results, three model runs were performed for each scenario with the hydrological model, and the mean of the three runs taken as the result.

Combined land use and climate scenarios

For the Upper Ouémé catchment (HVO), we simulated combined land use and climate change scenarios. Both climate scenarios were combined with the land use scenario business as usual. Figure 1 compares the mean renewable water resources (river discharge and groundwater recharge) for the period 1993–2003 and the scenario A1B period 2015–2025. The scenario shows a strong reduction in available water due to a drop in rainfall and increased temperature. For scenario B1, the reduction in available water was less significant than for scenario A1B. While for the whole HVO mean water availability was about 262mm/y for the decade 1993–2003, only 129mm/y were simulated for A1B and 141mm/y for B1 (2015–2025).

Climate scenarios Ouémé Bonou

The UHP-HRU model was also applied for the whole Ouémé catchment. As no land use scenarios were yet available, climate scenarios were calculated with constant land use.

Figure 2 shows the results of the climate scenario modelling. Like the results for the Upper Ouémé catchment, the amount of renewable water decreases for both future scenarios compared to past decades. The highest decrease is observable for the A1b-scenario, caused by an extreme decline in rainfall in the region. In the more sustainable scenario B1, the decrease in water resources is also significant compared to past decades, but less high than for A1B. The uncertainty bounds show the minimum and maximum of the three ensemble runs.

References

Giertz, S., Diekkrüger, B., Jaeger, A. and Schopp, M. (2006): An interdisciplinary scenario analysis to assess the water availability and water consumption in the Upper Ouémé catchment in Benin. Adv. Geosc., 9, 3–13.

Thank you for your attention!

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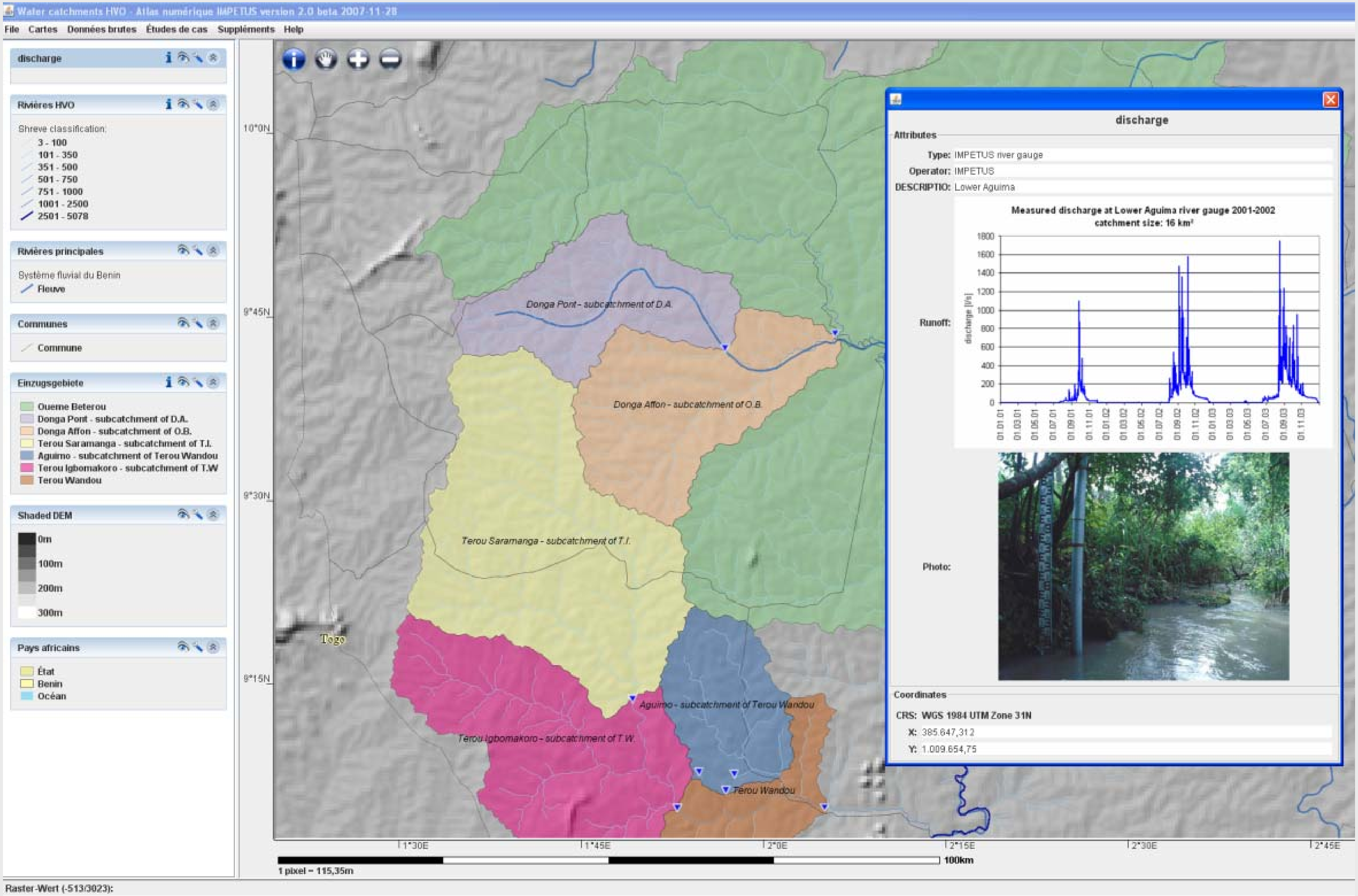
Introduction: WORKFLOW from Problem to Action

Problem ⇩	Climate Change Land use change Hydrologic conditions..
Data ⇩	Satellite Data Measurement data Socio economic data….
Information ⇩	Spatial- / temporal patterns of changes, Indices….
Understanding ⇩	Process dynamics Actors Motivation …
Action	Political measures Technical measures …

Introduction: WORKFLOW from Problem to Action

Problem ⇩	Climate Change Land use change Hydrologic conditions..	fast changes, limited resources..
Data ⇩	Satellite Data Measurement data Socio economic data….	big variety divers spatial and temporal resolution and quality
Information ⇩	Spatial- / temporal patterns of changes, Indices….	different quality divers methods …
Understanding ⇩	Process dynamics Actors Motivation …	modeling scenarios publications.
Action	Political measures Technical measures …	decision support …

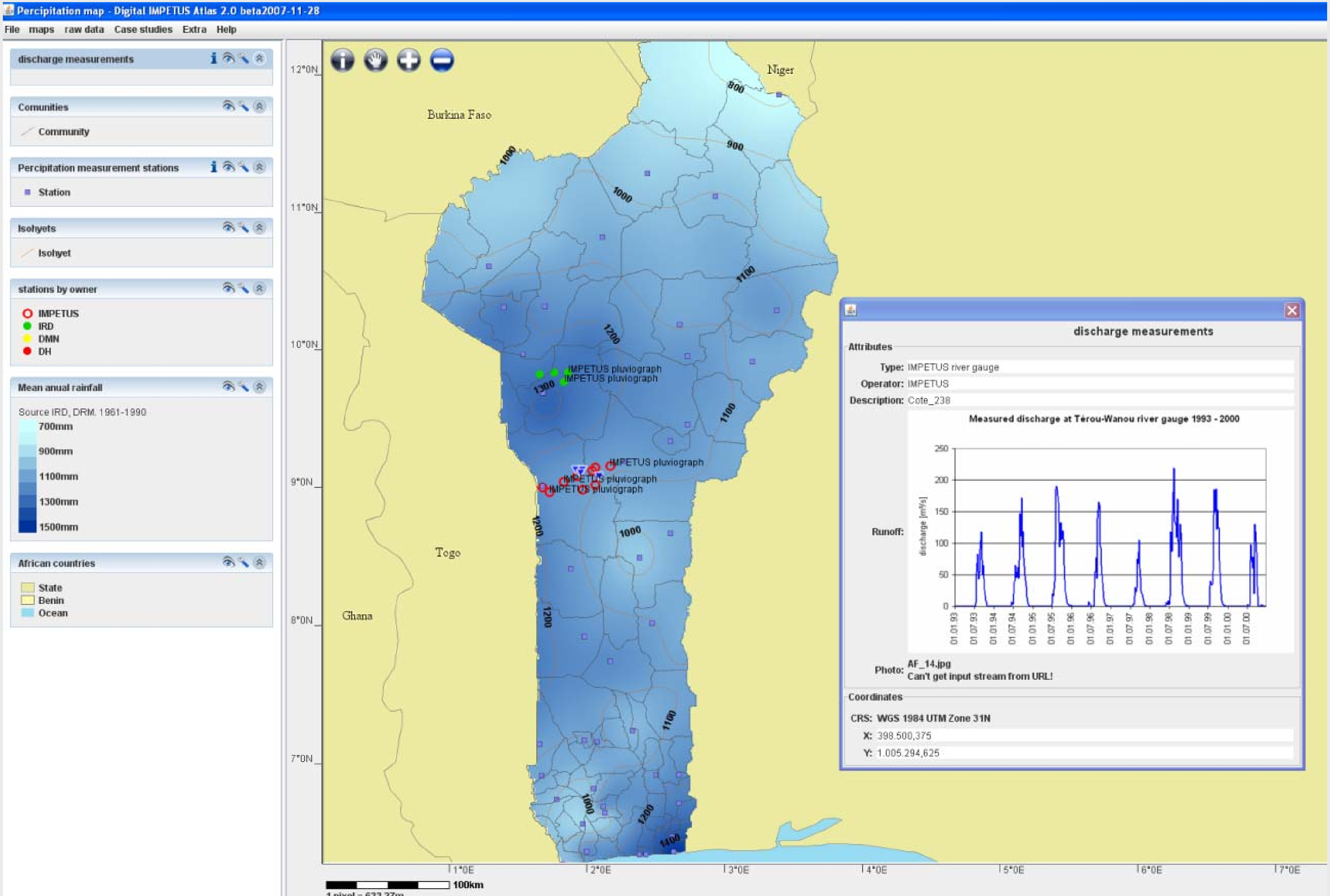
Relevant information can be recalled



Interactive Digital IMPETUS Atlas
Concept

- Digital visualization of base information and IMPETUS research results
- Documentation of the meta data
- Ability to present different, interdisciplinary parts
- Display of different information layers at the same time
- Possibility to deal with data and information in different spatial scales
- Enable data maintenance and integration of more datasets

Example



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File maps raw data Case studies Extra Help
discharge measurements
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Source IRD, DRM. 1961-1990
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State
Benin
Ocean
Burkina Faso
Niger
Togo
Ghana
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Interactive Digital IMPETUS Atlas: features

- Multi lingual
- Big raster data can be displayed
- Improved features for metadata are available
- Hot links are possible
- Own maps can be created
- Improved printing features
- Export of data is possible (if datasets are free)
- Some analysis features are included

Question:

How to communicate and distribute research results and base information (data, maps, reports) to stake holder and other interested people?

Scientific papers

+ very sound information

- very expensive

- only for experts

- language

- data not available

Web presence

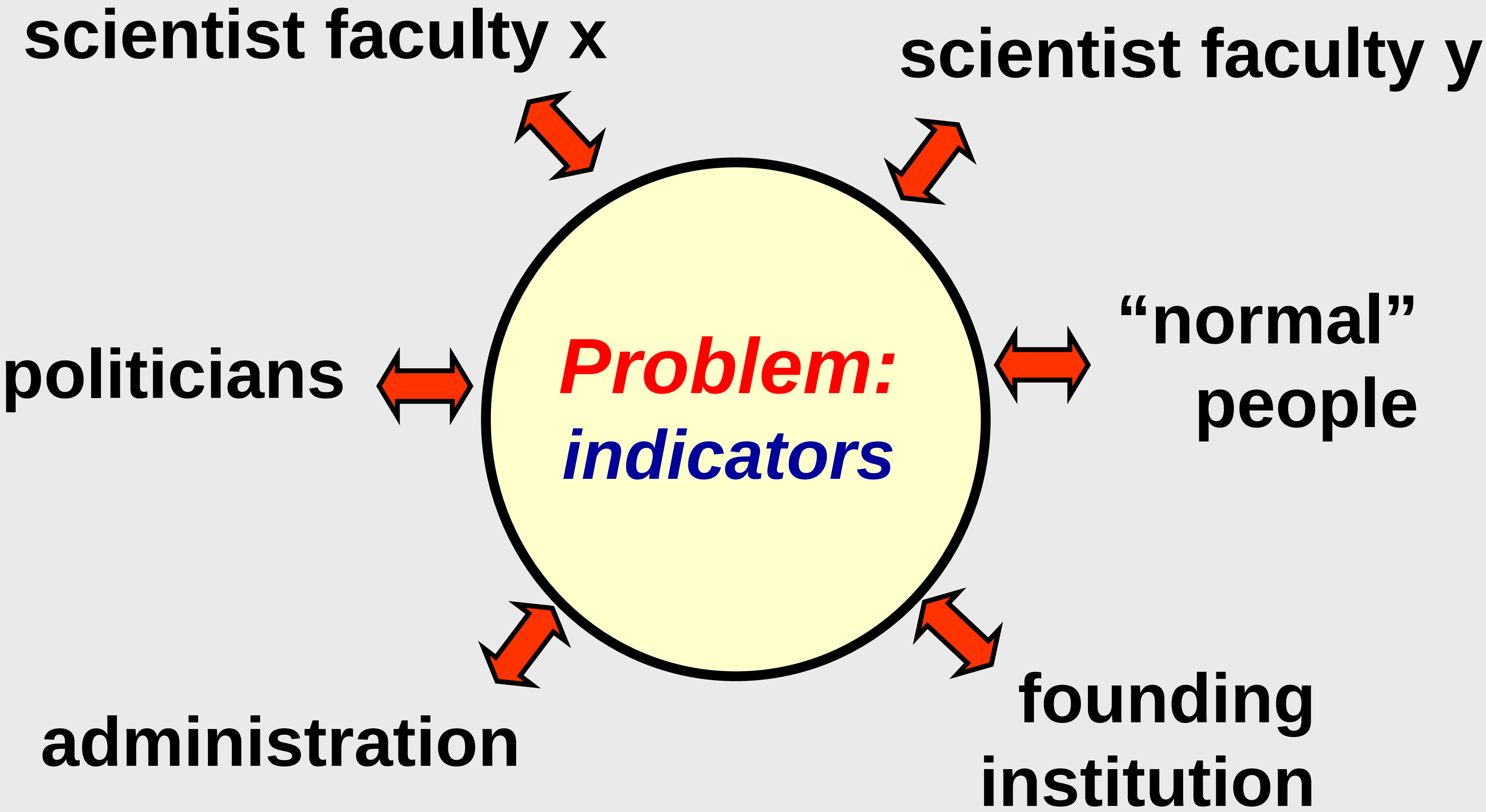
+ much information

+ data available

- cost of maintenance

- demands internet connection

why is difficult to understand complex problems?



necessity for communication!

Introduction: Workflow from problem to action

Problem

⇩

Data

⇩

Information

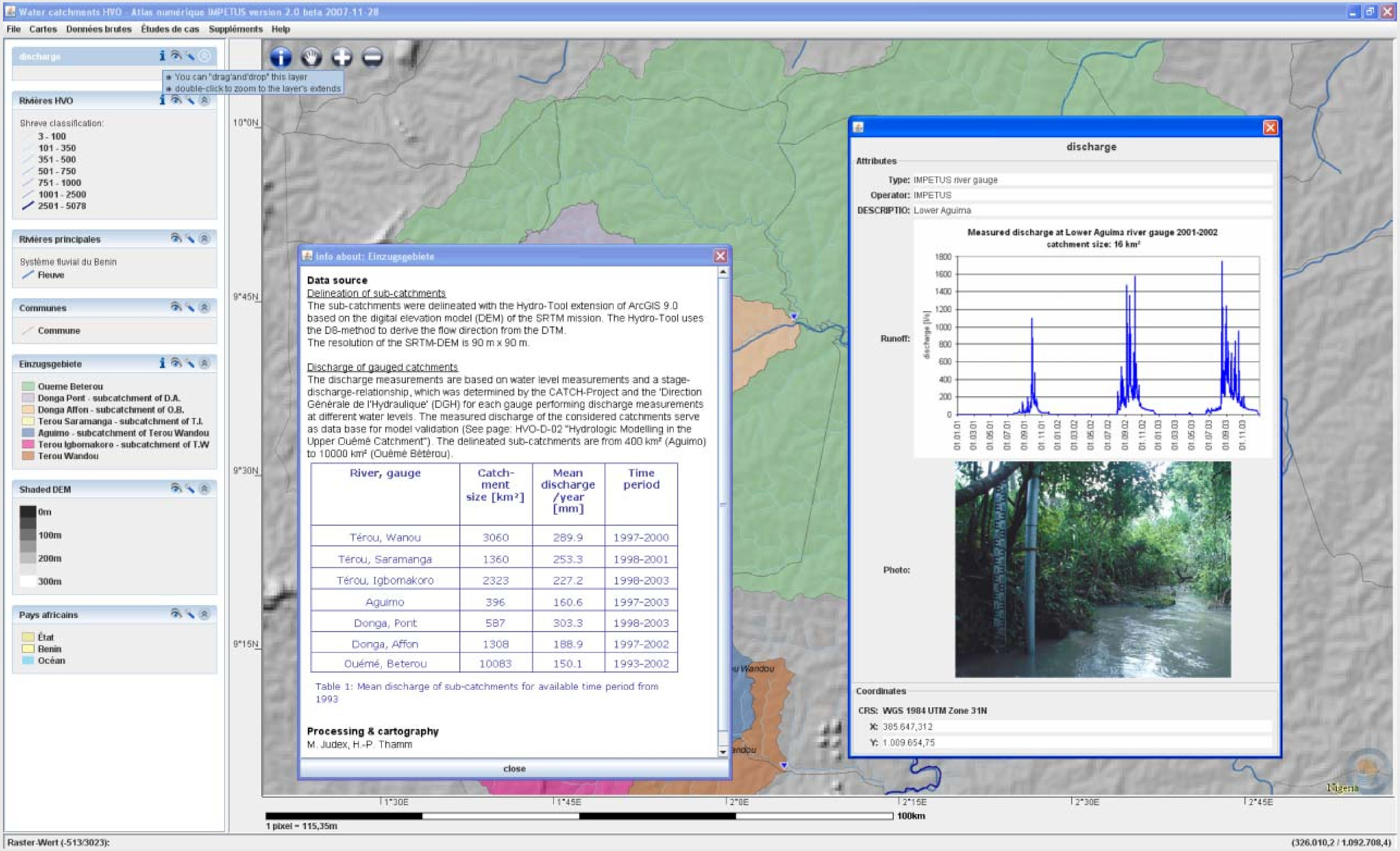
⇩

Understanding

⇩

Action

Metadata about the data and methods can be integrated



Concept of the IMPETUS ATLAS

Printed version

- **Short compilation of the particular topic on 2 pages with significant maps, figures and tables**
- **Text scientific sound, but understandable for interested “non experts” and decision makers**
- **Continuative bibliographical references**
- **Information on transparent sheets enable analyses by overlaying different layers.**

Data: Landsat-Mosaic Benin