DEFINITION OF AN ALARM SYSTEM TO ASSESS THE OBSOLESCENCE OF AFRICAN SPATIAL DATA INFRASTRUCTURES

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ABSTRACT

Reasons for obsolescence of spatial data infrastructures (SDI) have changed drastically. Classical reasons were linked to the evolution of landscapes and to technological breakthroughs. Products being proposed by legitimate organisations, decisions on obsolescence cases were based on consensual rules. Now those rules still apply but at a different pace, especially in developing countries where urban growth and changing landscapes face rhythms seldomly seen elsewhere. It is also true for sources and technologies which change faster. But for SDI stakeholders, new issues threaten the perceived value of their infrastructure. First, geospatial products and services are more and more used for different uses than their original intended use. Second, new actors (both from the commercial side and from the crowdsourcing side) present both opportunities and threats.

Even if strong arguments push to defend the need to build and maintain spatial data infrastructures, new sources, methods and organizations must be used to identify, assess and process obsolescence as soon as possible.

The availability of global coverage and crowd sourced data, integrated in a warning system, allow the stakeholder to be the first to anticipate future obsolescence. It also allows initiating the right communication with end users on perceived obsolescence.

We present a system developed for defense and oil & gas stakeholders allowing to assess African SDI obsolescence. It is based on alert systems on operational requirements, change detection, availability of sources to and competition from other products or services. Those alerts help to build a dynamic cartography integrated in a quarterly dashboard reporting.

Keywords: Spatial Data Infrastructure, Obsolescence, Crowdsourcing, Satellite Imagery, Monitoring, Africa

INTRODUCTION

An efficient Spatial Data Infrastructure (SDI) is a key for economic and sustainable development in African countries. For all parties involved (policy makers, military, private sector, foreign investors, civilian society, international organisations, …), there are strong expectations for products and services (classical and digital) up to date, reliable, and tailored to operational requirements. And this is true at all levels (local, national, sub-regional or continental).

For years in Africa, those SDI's have been created and maintained by western cartographic agencies, the only one able to have a sustainable effort for decades. Locally, economic operators would create limited SDI for their project (O&G, road, infrastructure development…) but those data would generally not be shared on the long term with local actors. Most of development decisions still have to rely on ageing cartographic series. In a lot of countries, 1960's or 1970's data are still the only available base layers. The decision for new editions is more often linked to the sales of the previous edition than to any willingness to update the data.

When this willingness exists, obsolescence issues are fairly simple to manage, being linked either to the landscape evolution (new infrastructures, urban growth, change in land cover / land use…), or to available new tools (new sources, new production techniques…). That is why we saw a lot of partial updates based on satellite imagery inthe 1980's, just because of source availability. Products being created by legitimate professionals, consensus was easy on obsolescence criterions.

More recently, new projects have florished, with public and private SDI financed by international projects, both in the civilian and in the military field (MGCP is a good exemple), or by economic operators. Those projects are generally based on modern but expensive sources (aerial or satellite coverages + ground work). Hence those infrastructures have a fairly high cost.

Classical criterions for obsolescence evaluation still apply, but stakeholders face new criterions:

- First landscape evolution has accelerated. In Africa, cartographers are faced with urban growth at speeds rarely seen in Europe (De Meulder B., 2010). But those evolutions happen also in rural areas. For instance, asphalted road network in Chad has grown from 300 to 2000 km in less than 4 years (Rousselin T., 2011).
- New sources and techniques also appear faster and this makes difficult an efficient and stable updating program over 10 to 20 years. This technological effervescence impacts all aspects : data collection, data management and production, data and services distribution (online or offline). In developing countries, it may have a catalytic impact but sometimes it just freezes any effort or financing (Rousselin T., 2010).

But for stakeholders, new "menaces" arise:

- Constant evolution of operational requirements makes it very hard to establish and maintain long term product lines and services. Users focus over a certain area is changing with time and the need to derive products or services from the basic infrastructure is also evolving.
- But the most stressful and distracting aspect is linked with the sudden weight of new actors, from the private sector (like Google or Microsoft) and from the collaborative fields (Easley D., 2010) (Shirky C., 2008) (Howe J., 2008). How to legitimate the slow and costly building of "your" SDI when Google updates its imagery three times faster and federates thousands of free workers to draw vector objects and fill attributes? How to keep the credibility of "your" project when any geotagged picture on Flickr or Panoramio gives instantly "the" proof that this dirt track is in fact now a 2 lane black top road? How to face criticism on your products based on the fact that as soon as you deliver them, users can check them against crowd sourced photos, videos, GPS tracks, or Open Street Maps productions…?

SDI reputation and the consequences on the stakeholder's own reputation is more at risk than ever in a period where there will be more and more scrutiny on investments. Even if strong arguments push to defend the need to build and maintain spatial data infrastructures, new sources, methods and organizations must be used to identify, assess and process obsolescence as soon as possible. They must allow the stakeholder to be the first to know predictable, possible or recorded obsolescences. Based on this knowledge, it will be possible to play with various drivers (Figure 1) to ensure long term trust and confidence from the users (and the lenders).

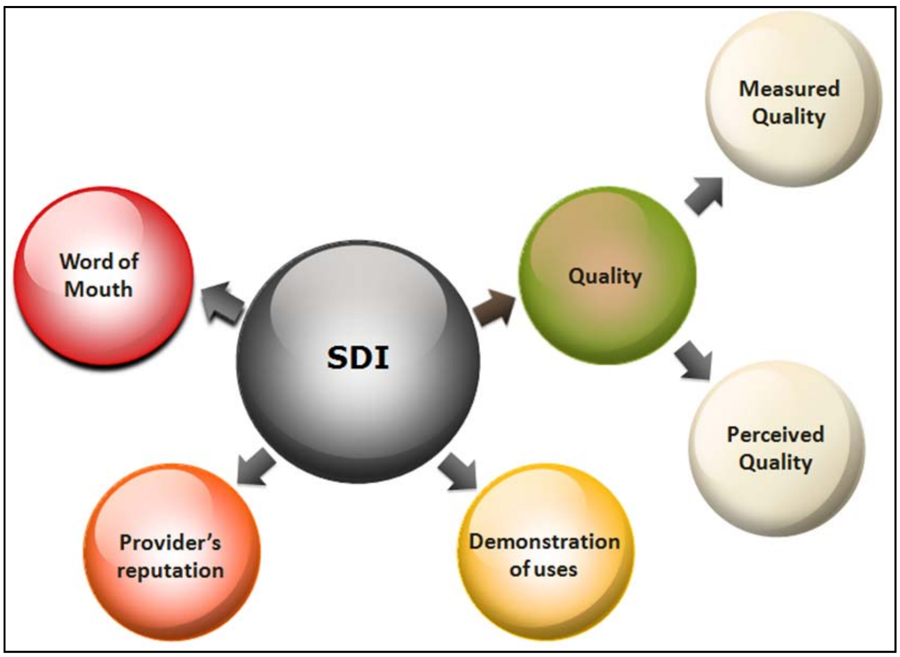

Figure 1. Different drivers for SDI reputation.

There are a lot of ideas, methods and tools for a better integration of geospatial Open Source Intelligence in classical production workflows (Rousselin T., 2008). The authors have developed such a methodology for the french Defense. But our ambition with the SAPO system is different.

The stakeholder must at any time consider the global quality of the information included in its SDI and be able to discuss decisions. Of course, one of the key procurements is to leverage those decisions with the right priorities.

Consequences could be either decisions on infrastructure updating cycle (partial or global), or publication of alerts for the end users on thematic or local obsolescence. They could also lead to the search of new partners willing to bring complementary pieces of information.

A MULTI ALERTS SYSTEM

The proposed system relies on three main triggers:

- Appreciation of the SDI Ageing process,
- Appreciation of outside events both geographically (e.g. new infrastructures, urban growth, catastrophies, war situations…) and in terms of new sources (e.g. imagery allowing to do what was impossible four years ago), products (e.g. open data layer which could be integrated to improve our product), or new competition (existence of a project or a new product which will eventually cast a shadow on our own infrastructure),
- Appreciation of evolving operational requirements both at the decision maker and at the user levels.

Information search is presented in Figure 2.

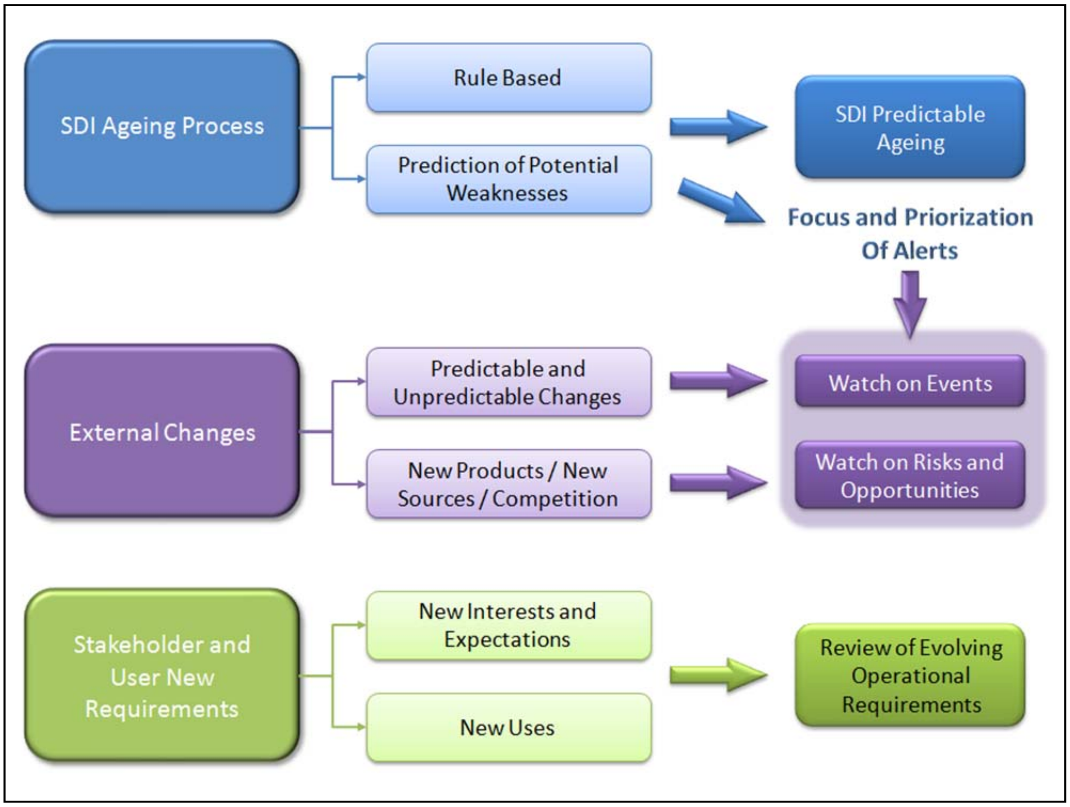

Figure 2. Information search on predictable, possible or recorded obsolescences.

Depending on the required information, various channels and sources will be used to obtain the maximal efficiency in the identification of events at the lowest cost (Figure 3).

- For major investments, imagery will be required to assess the veracity of the investment but at an earlier stage, authoritative sources will create a first and decisive level of alert. Figure 4 illustrates that point for the Chadian Refinery project in Djermaya (50 km north of the capital city N'Djamena). In 2001, this area close to Lake Chad is purely rural. In 2008, Very High Resolution imagery does not provide any difference from the 2001 landscape (except for seasonal aspects), while authoritative sources inform that the Chinese oil company CNPC and the Chadian government have signed the creation of the Joint Venture for the refinery project. In 2010, imagery is again of paramount importance to verify how infrastructure development is going.

- For other events, the balance between the various sources may change drastically, imagery or crowd sourcing becoming eventually the sources of choice).
- For slower evolutions like urban growth or land use, change detection is the key. Hence, imagery is the most important source.

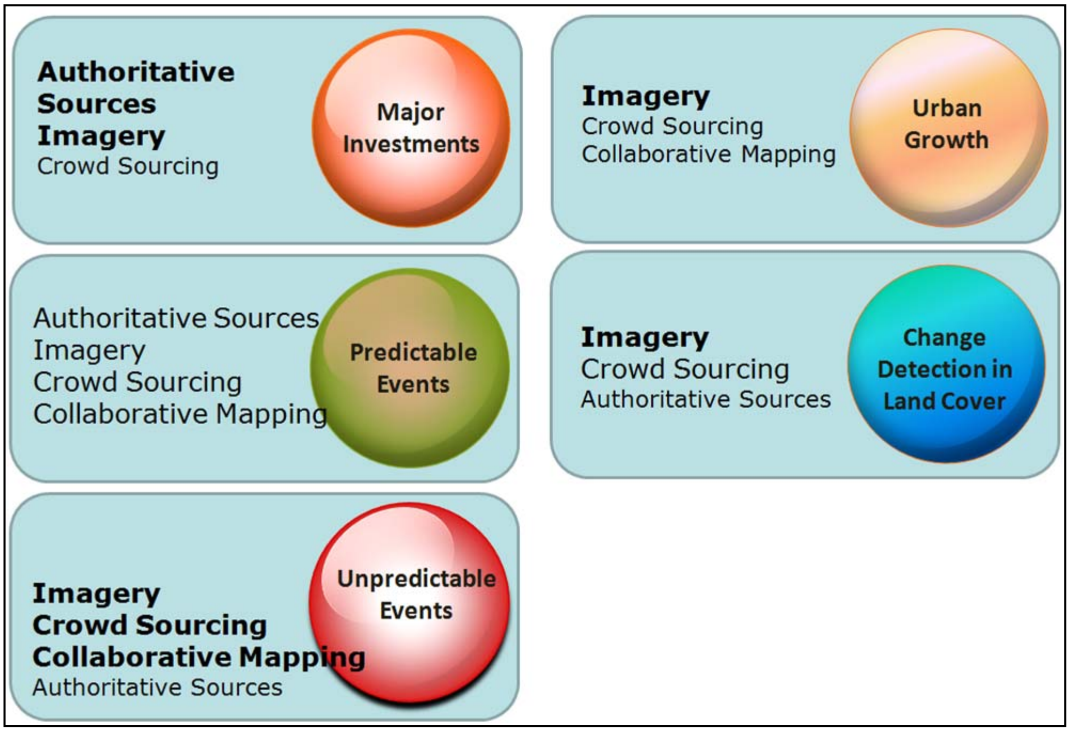

Figure 3. Relation between events to be assessed and possible sources of information.

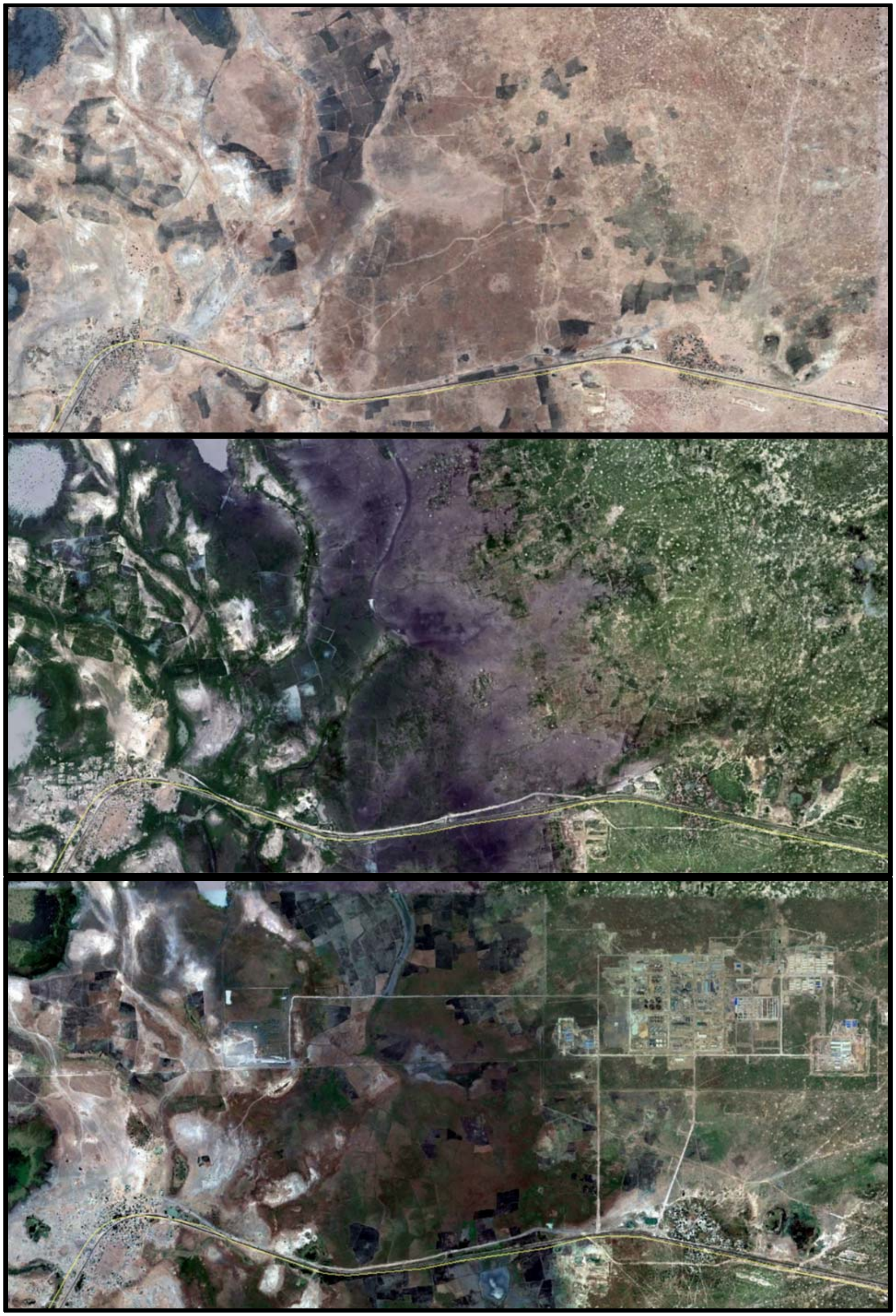

Figure 4. Situation in 2001, 2008 and 2010 on the Djermaya Refinery site in Chad.
Source: Ikonos-2 and GeoEye-1 imagery - © GeoEye 2001, 2008, 2010
Comment : In 2008 (middle image), authoritative sources give essential information to set an alarm to be confirmed in 2010 on imagery. This illustrates that imagery is not always the best source at a given time.

A QUARTERLY REPORT

Every three months alerts are collected and evaluated:

- Alerts on the evolution of the area of interest: evolution of a particular area, key investment, industrial or natural catastrophy, political or military event of large magnitude (depending of course on the SDI content).
- Alerts on risks and opportunities in the area (and especially on new geospatial products or services available or announced) and their potential consequences.
- Review of evolving operational requirements including new interests (leading to a greater focus on one particular thematic aspect or one particular area or location) and new uses (very often a SDI has been created for a range of uses and the stakeholder must inform its users if the SDI is not adequate for certain new uses – and eventually how to cope with this problem).

Decisions on those alerts feed a dynamic mapping system on obsolescence risk (Figure 5). In the first implementation of the SAPO system, which is aimed at an infrastructure created to derive 1/50 000 cartography, the basic cell is the square degree:

- If a major obsolescence is recorded, the fact that it affects partially or totally the surface is not relevant.
- If a minor obsolescence is recorded, it is possible to refine the analysis to evaluate more precisely its impact on the whole square degree. This analysis is a collaborative study performed by a team of geographers, intelligence specialists and people involved in the creation of the SDI and its derived products and services.

The dynamic aspect is essential because the value taken by one square degree on a particular quarter is less important than its evolution over time. Even if various topics evolve slower, the quarterly temporal cell is useful in order to detect and process non predictable events. It also allows correcting false predictions.

For instance, a new major dam will be detected many times: when it is announced for the first time, when it is precisely located, when the contract is signed, when field work impact the landscape on imagery, when the facility is officially inaugurated and when operational production is verified. Even if one of those six events is either missed or exagerated in consequences, the multiple occasions to check again provide a very fine quality control tool which will eliminate false starts and white elephants.

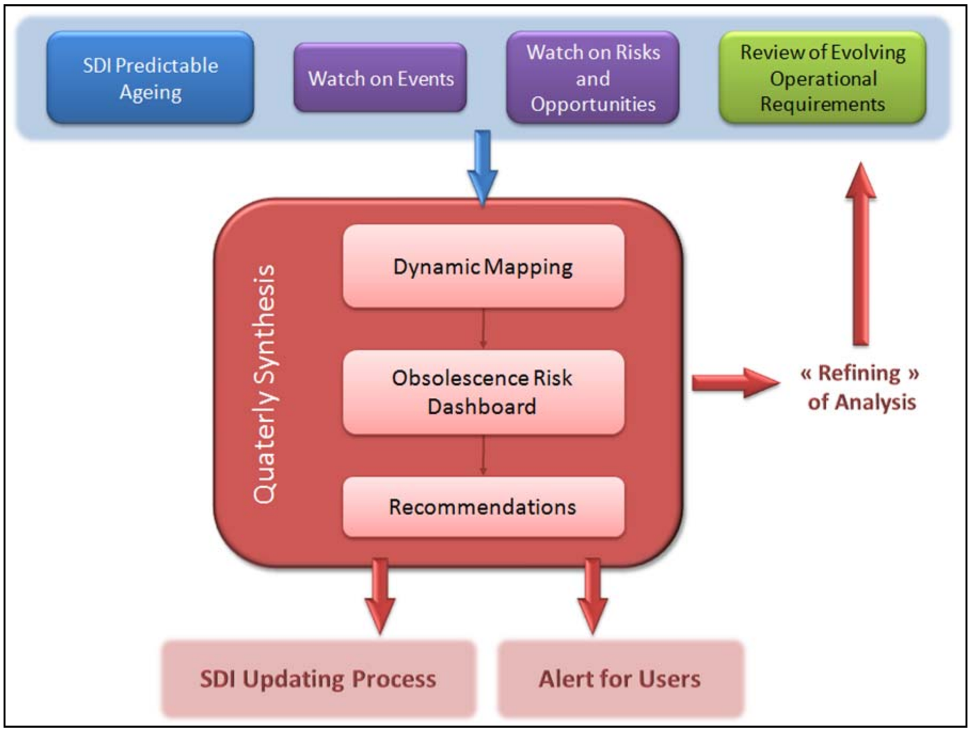

Figure 5. Presentation of the quarterly dynamic system.

CONCLUSIONS

The system is already implemented this year over six African countries to assess the obsolescence of a Defense SDI. Lessons learned from this first operation will be used to improve the system in order to propose alerts and warnings over multiple areas in Africa.

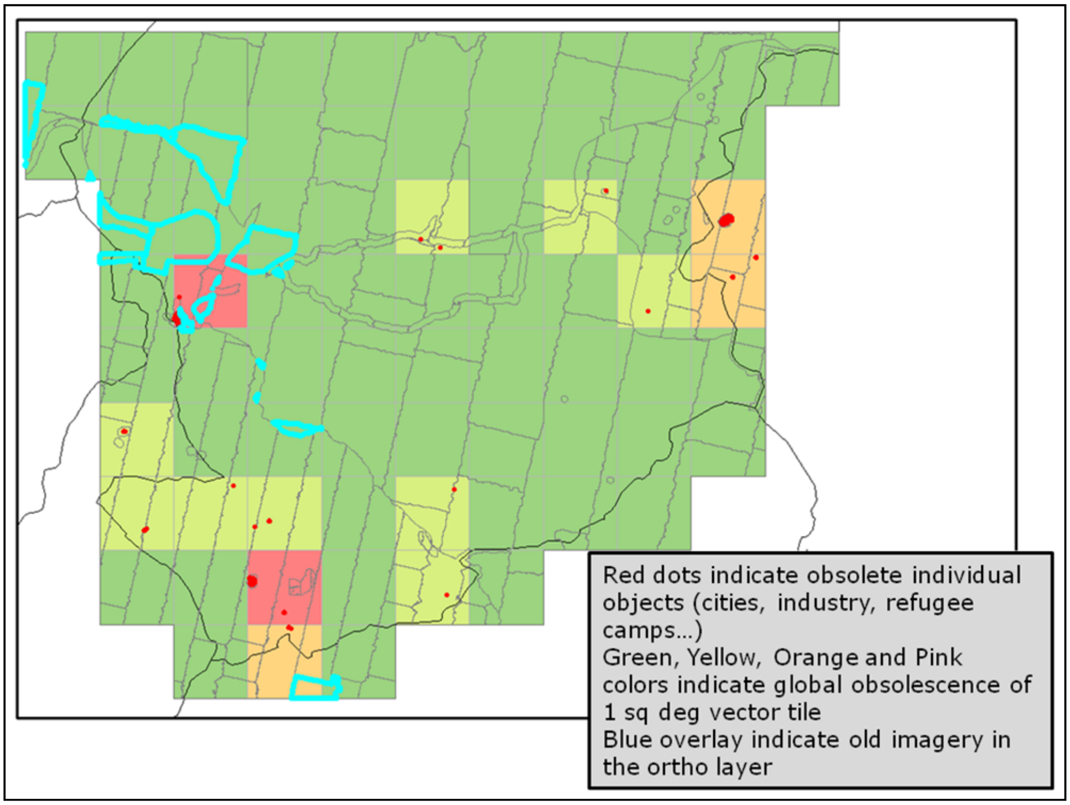

Figure 6. Exemple over Chad at a given time.

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