Requirements on EO Space & Ground Segment

- geoland Operational Scenario Findings –

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Scope

This paper presents key findings of the geoland Integrated Project on Earth Observation (EO) sensor requirements from a geo-information services perspective. The inputs shall support the on-going EC discussion on future sensor needs and ESA's Sentinel definition projects.

geoland as the European Commission's GMES lead project on " Land Cover & Vegetation" (LC&V) aims at supporting public bodies in charge of implementing European policies and directives through adequate geo-information services and tools. geoland exploits the unique capacity of Earth Observation data of providing unambiguous and real-time observations across administrative borders as regular time series. These observations are transformed into end-to-end information services integrating existing in-situ and statistical data sets.

Improving today's capacities, geoland aims at implementing reliable and sustainable GMES LC&V services addressing the mid- and long-term perspective. Thus, availability of, and access to adequate EO data assured over decades is crucial. The project is structured into three Regional and three Global Observatories, each of them supported by a Core Service providing basic geo-information inputs.

These two Core Services bundle the requirements on EO data in terms of sensor specifications and capacities (Space Segment) as well as data access conditions (Ground Segment). The geoland task "Operational Scenario" translates the consolidated service requirements into technical requirements with respect to operational GMES LC&V service provision. Considering short-term opportunities and mid-term needs, an analysis of existing elements enables to identify today's and tomorrow's gaps and bottlenecks. The two next Sections, "European Land Monitoring", and "Global Land Monitoring" address the satellite data needs of the Regional and Global Observatories, respectively.

European land monitoring

Considering today's state of the practice, regional applications need at the highest priority a high-resolution multi-spectral platform (Landsat / SPOT type) offering a background mission for environmental monitoring purposes. Operational capacities shall cover the most of the area of Europe (~10 Mio km²) every 3 to 5 years – at least once during the vegetation period of the reference year – with plus/minus one year of tolerance. Multi-temporal coverage during a vegetation period is desirable for crop type mapping and monitoring addressing

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environmental aspects such as diffuse pollution of ground water, irrigation, soil erosion, and natural/semi-natural vegetation condition.

Spatial resolution shall support European reporting obligations with national/sub-national management needs. In terms of minimum mapping units this requires 1 to 5 ha for regional-scale mapping and 0.1 to 0.25 ha for local urban areas or hot spots (e.g. nature protection sites). The range of resolutions does not fit a single sensor type. 1 to 5 ha is achievable with 10 - 20 m resolution, whereas 0.1 to 0.25 ha requires 2.5 m – 5m resolution. The scope is to provide a granularity of information that enables identification of impact sources, and does not suppress fragmented landscape features (e.g. soil sealing, meadows).

Based on the current state-of-practice in using Landsat and Spot data, it is crucial for the discrimination of vegetation classes that the spectral resolution includes at least one band in the short-wave infrared (SWIR) range of 1.4-1.6 μm in addition to the standard visible and near-infrared bands. An additional SWIR band (around 2.2 μm) seems to be beneficial to enable better or improved assessment of Mediterranean vegetation conditions.

In addition, selected regional applications require seasonal information and bio-physical parameters[†]. The current assumption is that this is only achievable at reasonable cost using medium-resolution sensors from 50 – 300 m pixel size (i.e. "MERIS or AWIFS type"). However, the existing MERIS data are not presently available for operational near real time applications, whereas they fit offline applications. The operational requirements of the European land monitoring community handshake with the global land monitoring community needs. Whether this is in line with the coastal and open ocean communities operational requirements is under evaluation within the Sentinel 3 study.

As complement, a very-high-resolution (1 to 2.5 m) sensor is required to enable mapping of major conurbations. This requirement is driven by Urban Mapping services analyzed by GSE Urban Services, intentionally not addressed by geoland to avoid duplications.

The use of radar imagery (SAR) for the identified geoland services today may be state-of-the-art for a few applications, but is not yet accepted state-of-the-practice. Further evaluation shall be left to a next generation of GMES service consolidation supported by the up-coming series of European and International SAR sensors (e.g. Radarsat-2, TerraSAR).

To ensure continuity and sustainability regional services have been defined towards multi-mission EO data inputs eligible within a feasible bandwidth of quality parameters. To ensure EO data availability today – and most likely tomorrow – multi-mission tasking and ordering is seen as crucial to ensure operational data streams. This requirement is partly addressed by ESA's Heterogeneous Mission Access (HMA) study interfacing with geoland.

Today's EO monitoring capacity for regional applications is characterized by a limited number of available EO missions (i.e. SPOT and IRS, together with some scientific missions like ASTER). The experiences gathered in recent years show that – in a time-frame of 3 to 5 years – a multi-mission coverage of most of Europe can be achieved. Nevertheless, beyond 2009 there is a severe gap ahead, as currently no follow-up missions are confirmed.

These geoland findings have been communicated to Sea's Sentinel-2 Definition study team.

[†] E.g. Agricultural crops discrimination, crops management (environmental) conditions monitoring (important for diffuse pollution assessment), or wetlands status characterization.

Global Land Monitoring

Global applications need continuous, (near) real time, and secured provision of global biogeophysical variables of three kinds: radiation, water (including precipitation) and vegetation. As stated in the overall GMES objectives, Europe should ensure its own autonomous capacity also in that field from 2008 on.

The provision of radiation (such as albedo, temperature, radiation flux) and precipitation variables is and will be assured by meteorological EUMETSAT and NOAA satellites. Soil moisture variables will be delivered operationally through the ASCAT scatterometer instrument onboard the EPS satellite series of EUMETSAT very soon. The Earth Explorer passive interferometer SMOS instrument is expected to provide in 2008 – 2010 very interesting soil moisture data complementary to those of ASCAT. Follow-on acquisitions of soil moisture with this technique may turn out to be most interesting.

By contrast to radiation and water variables, the provision of land and vegetation variables (land cover, LAI, fAPAR, burnt areas) is not assured beyond the 2008 timeframe because of the inevitable loss of ENVISAT and VEGETATION data provision in 2008-2010. We note that the embarkment of an instrument dedicated to vegetation monitoring is envisaged on the sun-synchronous meteorological platforms, but only in the Post-EPS context, that is, beyond 2020. A gap is clearly identified between 2010 and 2020 for the provision of vegetation variables, that at the moment is not clearly covered by the Sentinel 3 mission.

Therefore, for the global geoland applications, the first priority is a continued provision of a well calibrated moderate resolution multi-spectral instrument to provide land and vegetation products. The continuity of the VEGETATION, MERIS and ATSR missions beyond 2010, possibly as a component of an ESA Sentinel 3 mission, is seen as crucial. In addition it is important to assure continued exploitation of the existing instruments (in particular VEGETATION) until the deployment of this gap-filler.

The requirements for such a mission are a high temporal repetiveness, at least once a day at the equator, a moderate spatial resolution, 1 km or better (up to 1/3 to ¼ km), a spectral coverage in the visible, near infrared, shortwave infrared, and thermal infrared (typically 10 – 15 bands). The processing centre should be operational and provide Level 1 data in near real time.

It is important that the user community be associated to the specification phase of the instrument ; geoland is ready to contribute to this effort – direct involvement into the study is seen by this community as a key plus, as demonstrated by the well proceeding dialogue within the Sentinel-2 work.

Finally, we recommend that actions be taken in order to benefit from real time availability of data acquired by operational sensors operated outside Europe, both for multi-sensor purposes and for assuring permanent operational data acquisition in case of system failure.

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