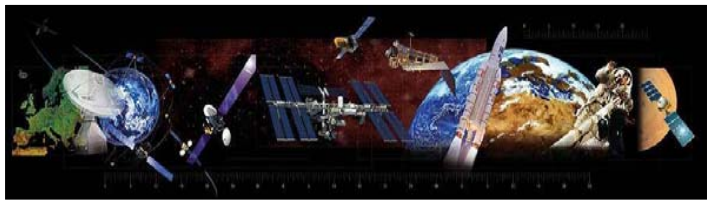
Space Assets for Demining Assistance

Feasibility Study

Integrated Applications Promotion

European Space Agency



Space Assets for Demining Assistance
Integrated Applications Promotion
European Space Agency

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Integrated Applications Promotion

Integrated Application Promotion (IAP) aims to:

- Incubate sustainable services that benefit society
  - addressing global / novel challenges
  - listening to needs of users
  - partnering with stakeholders
- Increase societal demand for satellite services
  - integration of multiple space assets yields new opportunities
  - assessment of added value

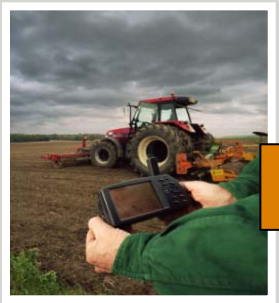
Some IAP Themes

- Agriculture
- Development
- Energy
- Fisheries
- Health
- Transport
- Safety

Integrated Applications Promotion

IAP Program Structure

- **Awareness Activities**
  - Understand, foster and organize user demand for service solutions
- **Feasibility Studies**
  - Assess technical and economical viability of these services
- **Demonstration Projects**
  - Implement pre-operational services
  - 50 % co-funding by stakeholders



User

Awareness

3 months

Feasibility

12 months

Demonstration

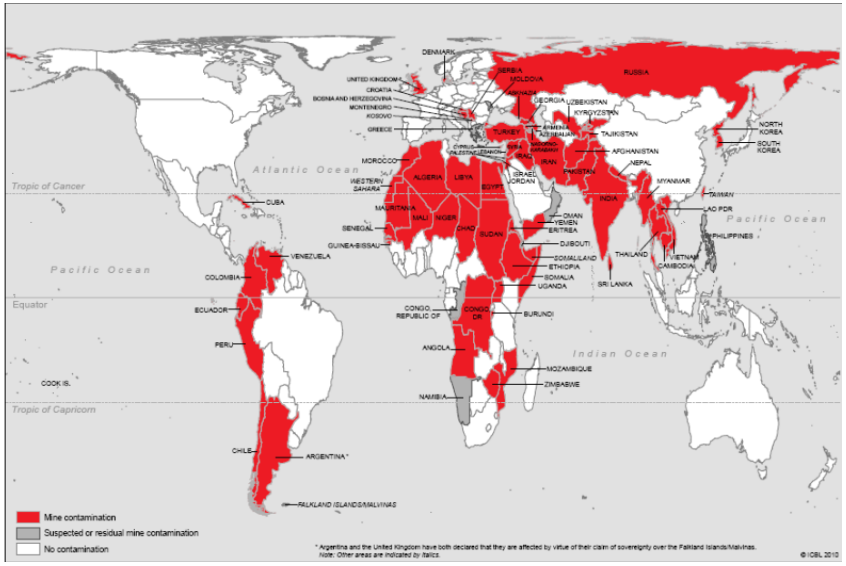
2-3 years

Service

The Mine Action challenge

Background

- Mines and explosive remnants of war claim thousands of civilian victims even after conflicts are over
- Resources (arable land, infrastructure, water, etc) located within areas suspected of mine contamination cannot be exploited - even if there are no mines
- 1997 Mine Ban Treaty : clearance within 10 years after ratification
- 2/3rd remains, ~3000 km2 remains mined (2009), 100 million mines
- >100 of million ERW also remain
- today about 4000 victims per year



Courtesy GICHD

Stakeholders in Mine Action

UNMAS & GICHD coordinate standards, information management, technologies

National Mine Action Authority / UNMAS sets up

National Mine Action Center (**NMAC**)

Alternatively **UNMAS, UNDP, UNOPS**

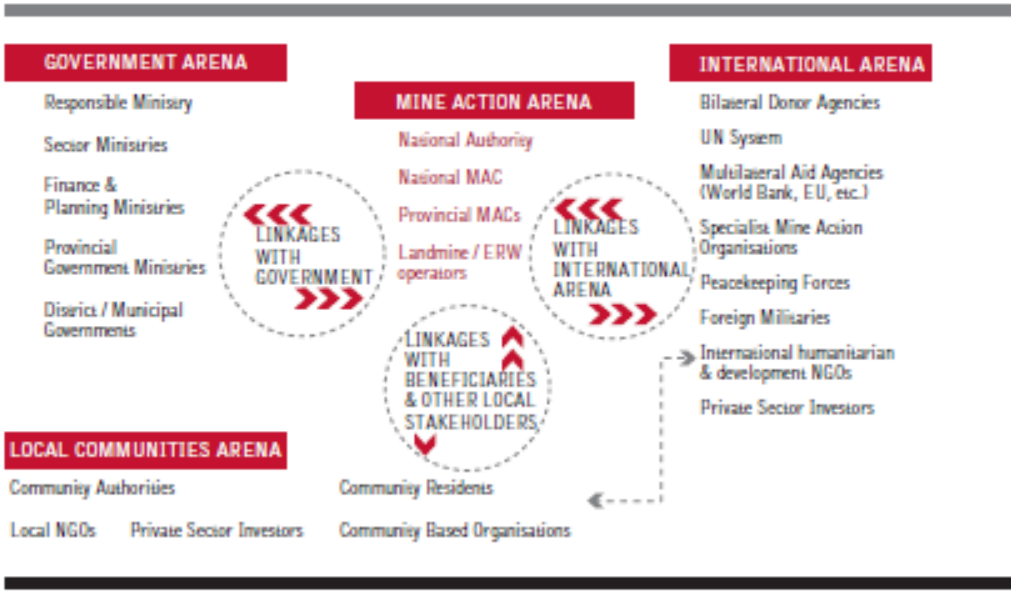
Regional MAC

Operations and advise by

- NGO's, e.g. **FSD**, **MAG, NPA**
- Commercial operators
- UN bodies
- Military

Paid for by **donors**:

- Red Cross
- ITF for Demining & Victim Assistance
- DoD



Courtesy GICHD

Demining issues

Post-war situation

Few infrastructure

Local staff & language

Extreme weather

Wide range of environments

Easily accessible mines mostly removed

- Budgets leveling off
- Donor constraints
- Trend towards integration with development
- Commercial demining

Demining current practise (detection & clearance)

Survey & Demarcation

- GPS
- Laser ranging
- Relative positioning
- Staff maps
- Google Earth
- GMS, VHF, HF, Satellite Phone

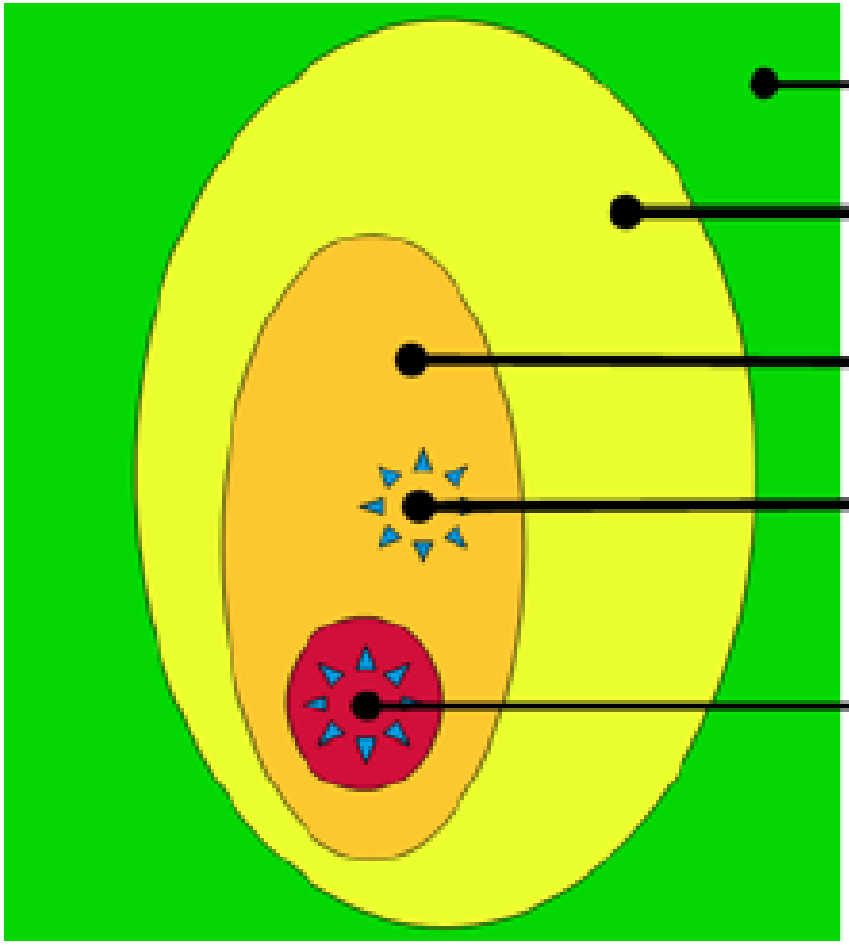
Detection

- Remove vegetation
- Prodders
- Metal detectors (& GPR)
- Tillers
- Mine action dog teams

Clearance is not an issue

No silver bullet technology

Demining current practise (Land release IMAS)



Land in use - OK

Suspected Hazard Area (SHA)
(based on General Assessment, unspoiled territory)

Confirmed Hazard Area (CHA)
(based on Non-Technical Survey: records, damage. Unspoiled?)

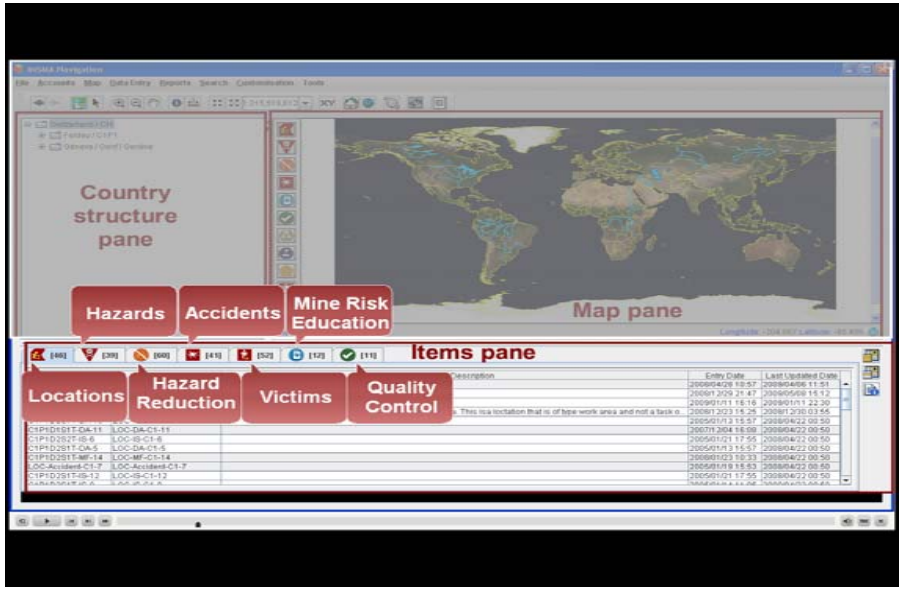
Mines
(presence suspected but not yet directly detected, this part of CHA will be subjected to Technical Survey soon)

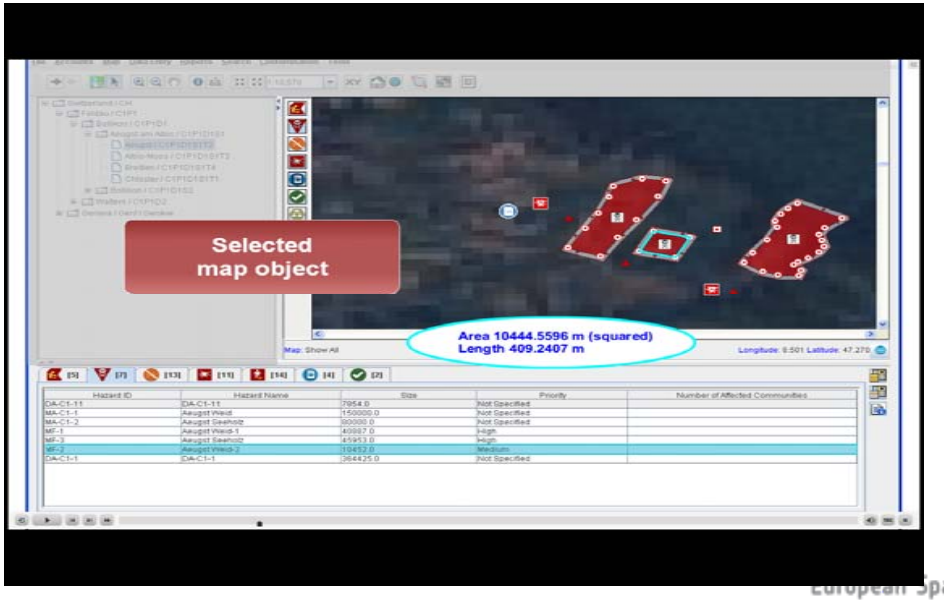
Defined Hazard Area (DHA)
(based on partially completed Technical Survey: test lanes have indicated mine presence and pattern but mines not yet all cleared)

Demining current practise (Information Management)

IMSMA : Information Management System for Mine Action, by GICHD

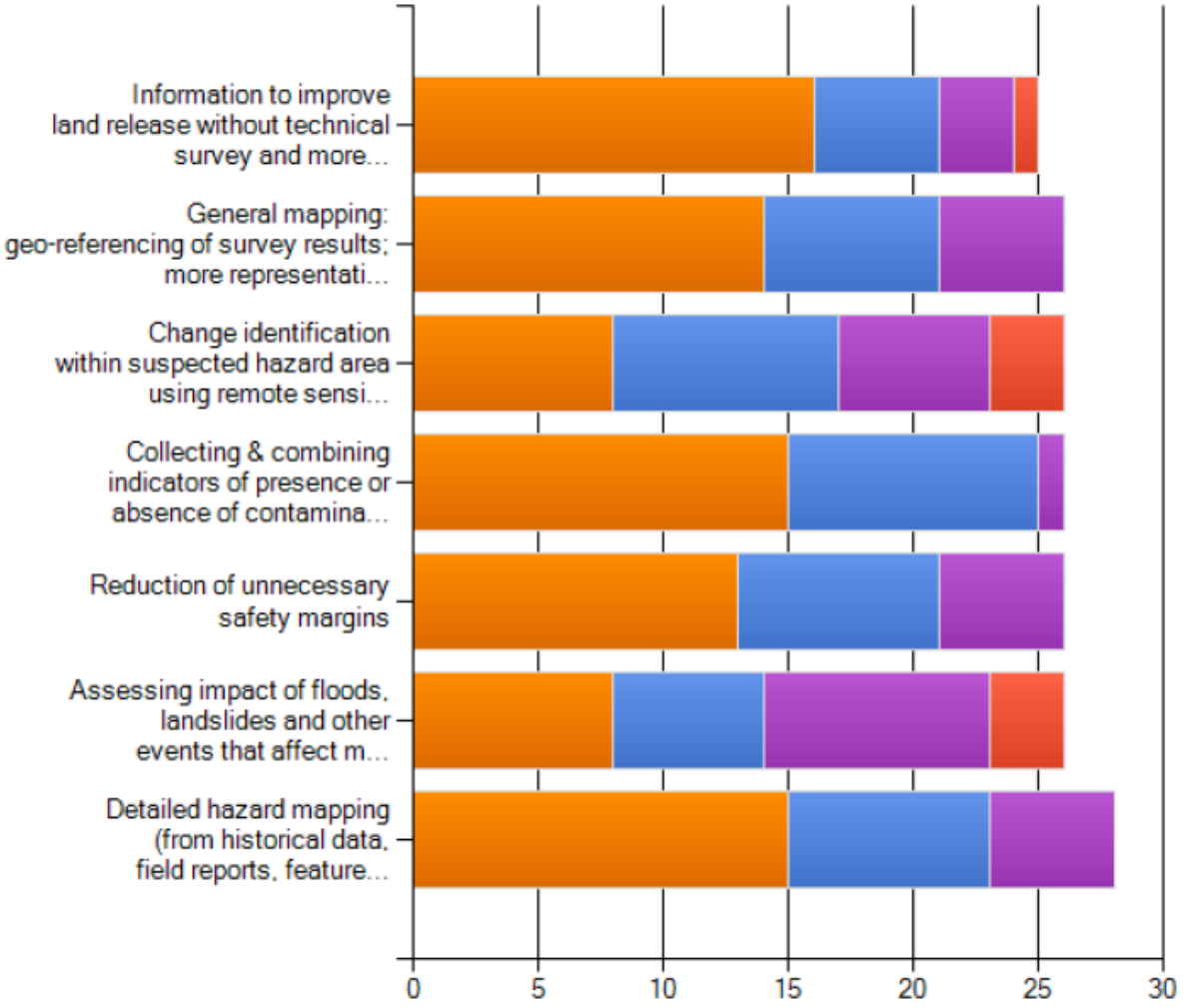
- Data entry & validation
- Data search & reporting





Demining Needs

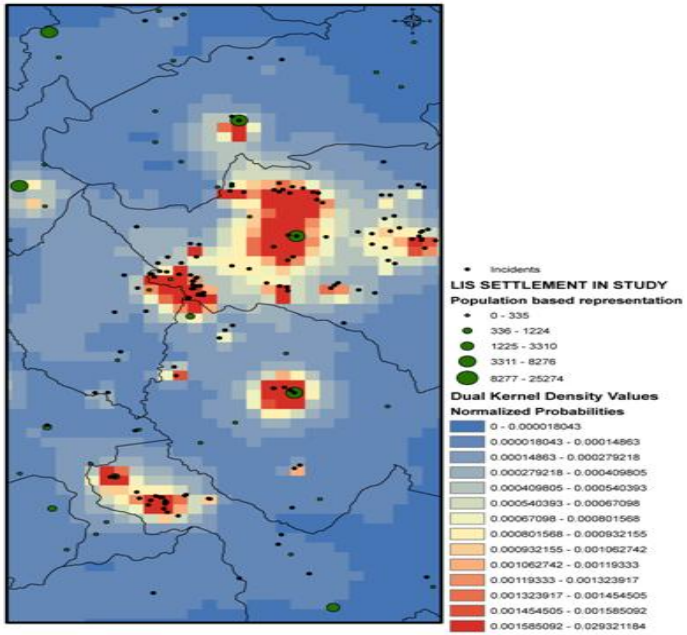
Please rate the "Relevance" of the following Non-Technical Survey activities/services to your organisation and region/country (*)



Demining Needs

90-97.5% of suspected land proves in hindsight to be uncontaminated

1. *Target with priority those minefields that are most threatening and costly to society.*
2. *Avoid the unnecessary deployment of clearance activities in non-contaminated areas.*
3. *Reduce the cost of detection and clearance per unit of land area (by planning, mapping, procedures, communication, detection).*

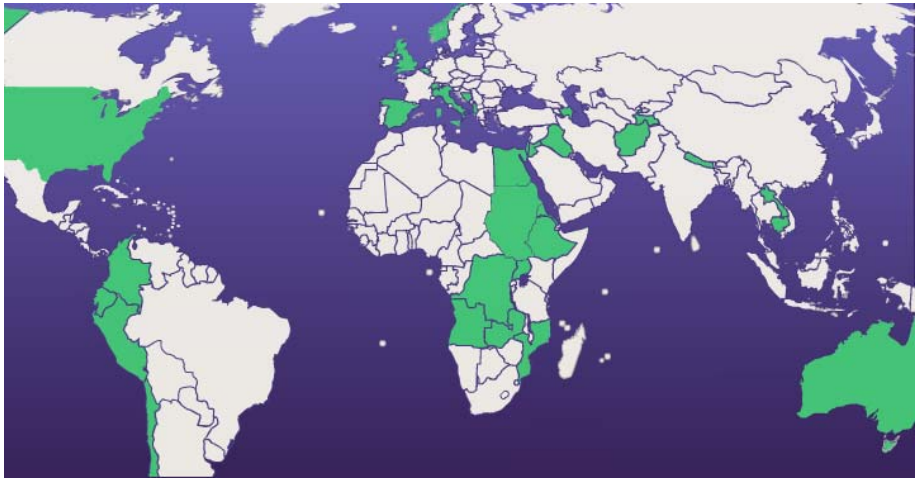


Incidents density versus population

Space Assets for Demining Assistance

Objective of SADA Feasibility Study

- Improve planning & efficiency of existing de-mining procedures
- By integrating space services with:
- field survey,
- clearance and reporting activities,
- aerial remote sensing
- (geospatial) information management system for mine action (IMSMA).

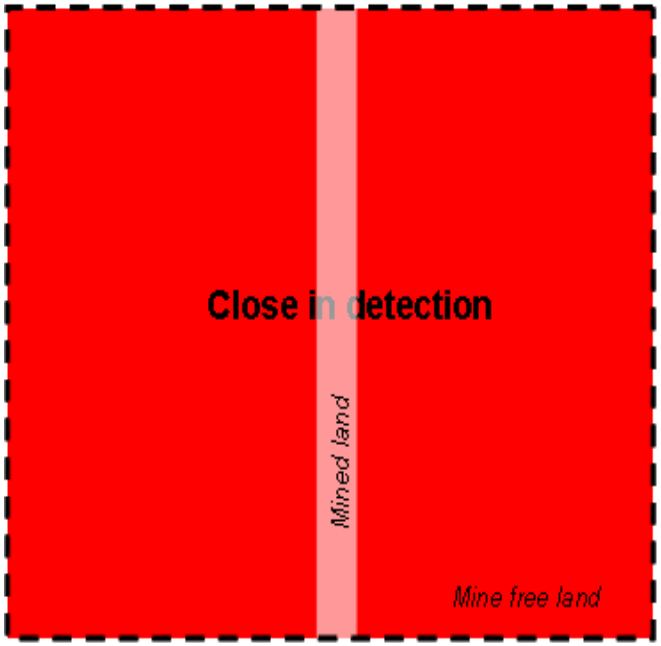


Stakeholders involved

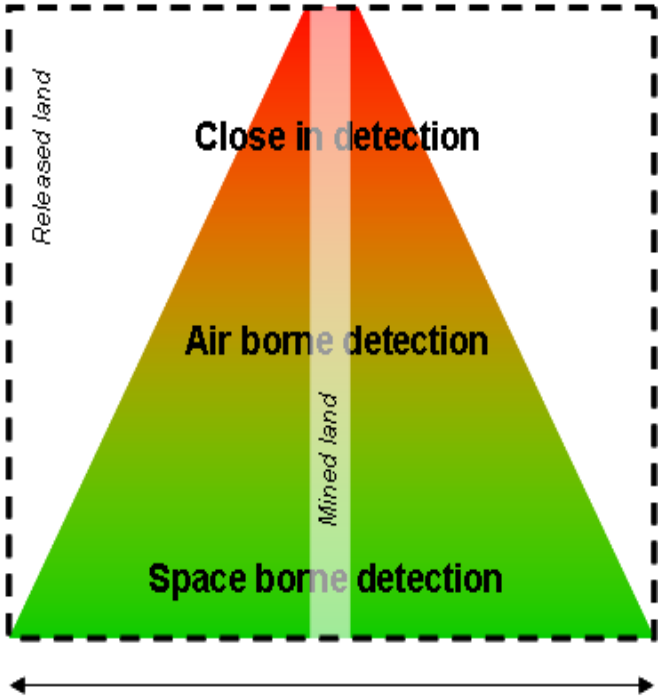
- 3 consortia (led by resp. Infoterra [UK], Radiolabs [IT] and INSA [E])
- GICHD as observer & advisor to ESA
- Over 30 user organizations in 20 countries
- **Proofs of concept** in Bosnia, Afghanistan, Chile, ...

Potential of space assets: land release

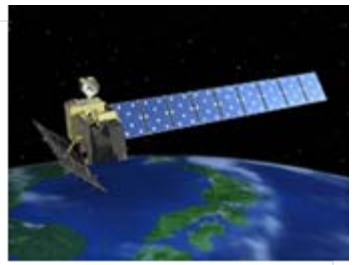
Actual situation



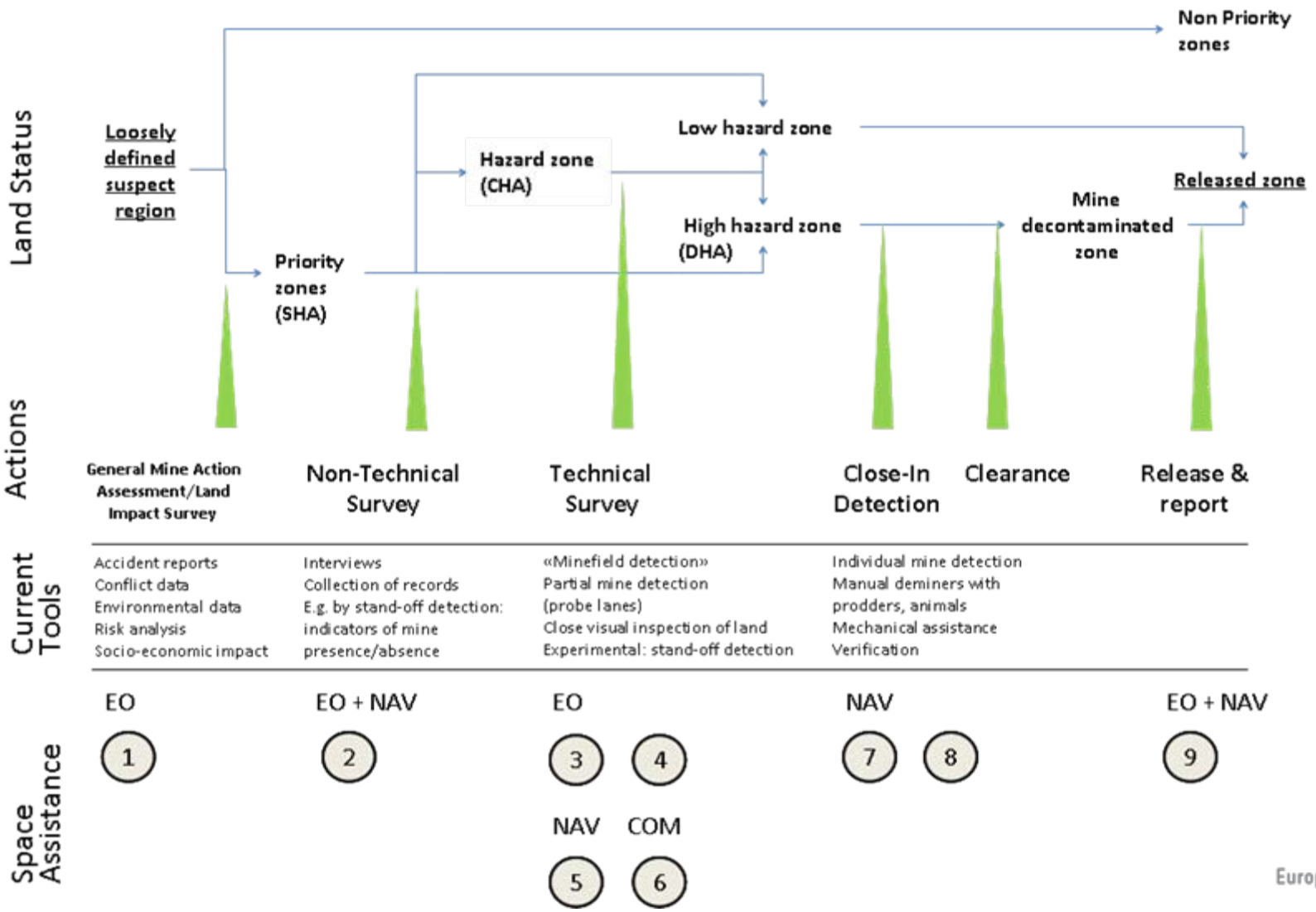
Desired situation



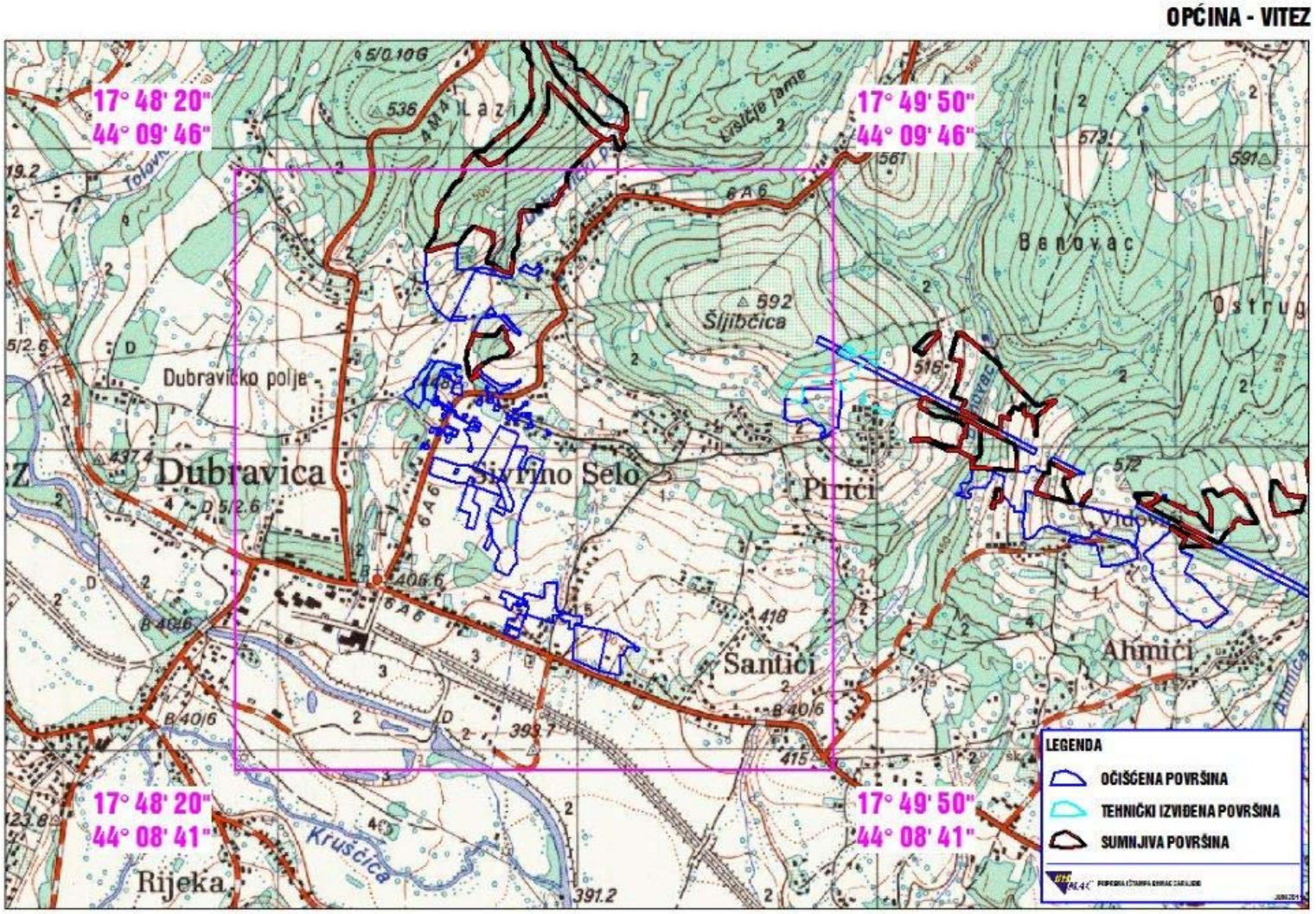
Amount of suspected land addressed



Space Assets for Demining Assistance

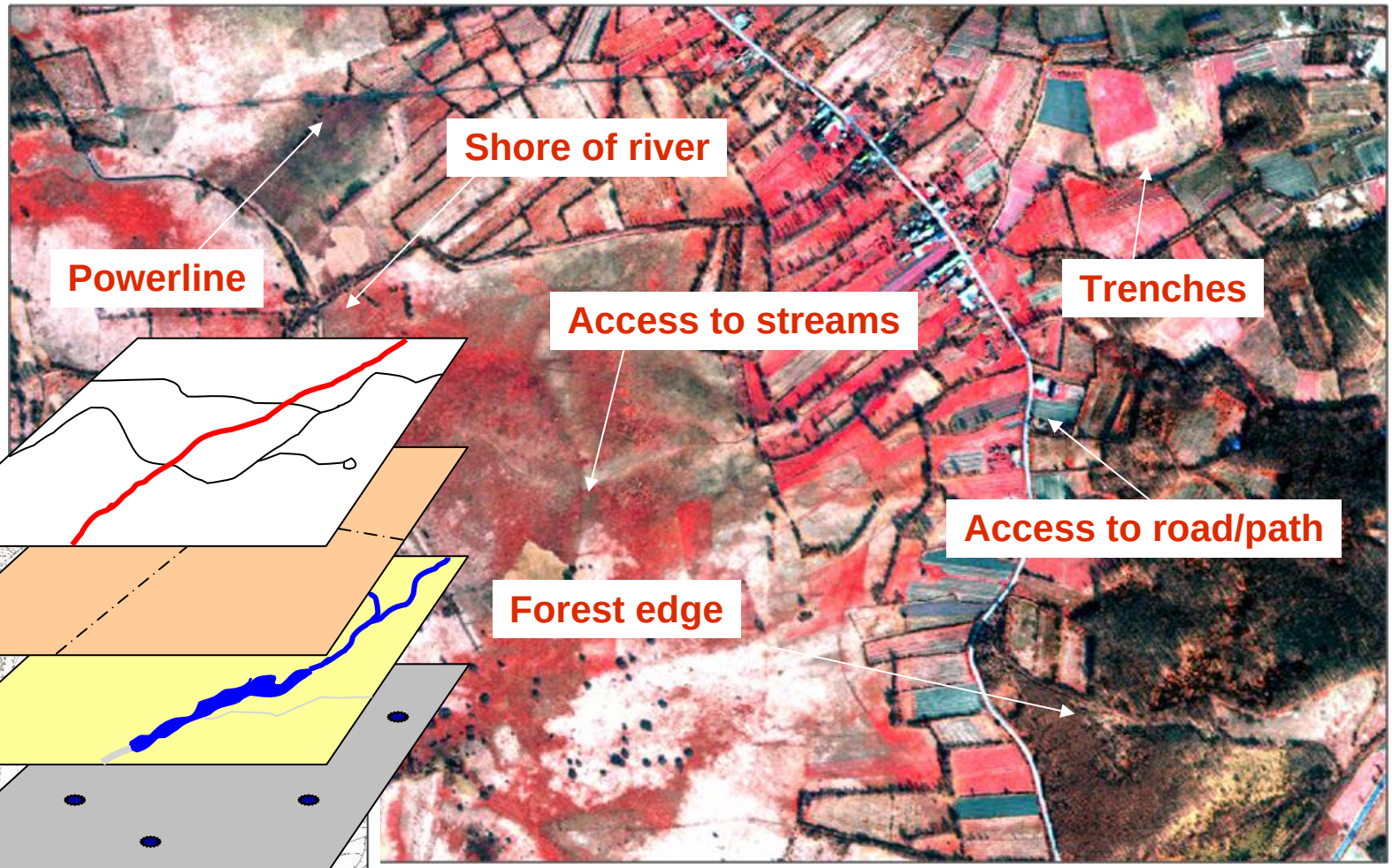


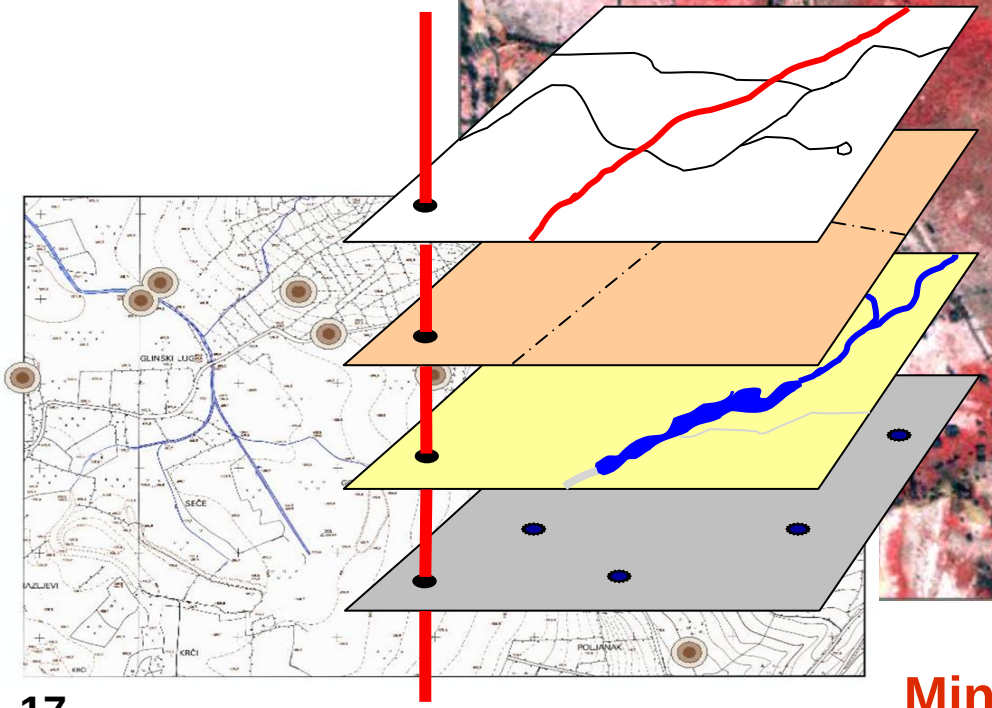
Potential of space assets : indirect indicators



Potential of space asset integration: ARC, 2003

Minefield Indicators

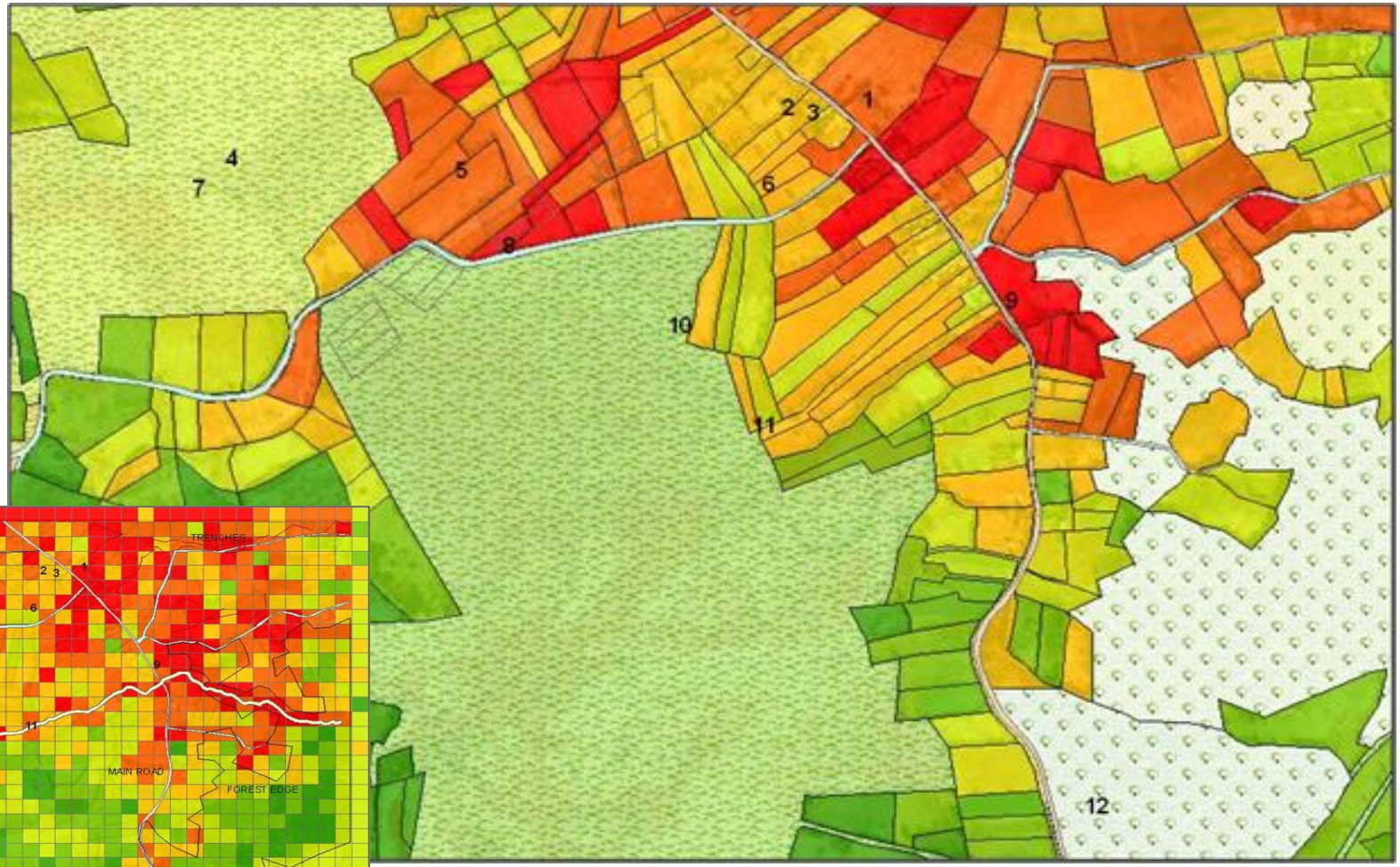




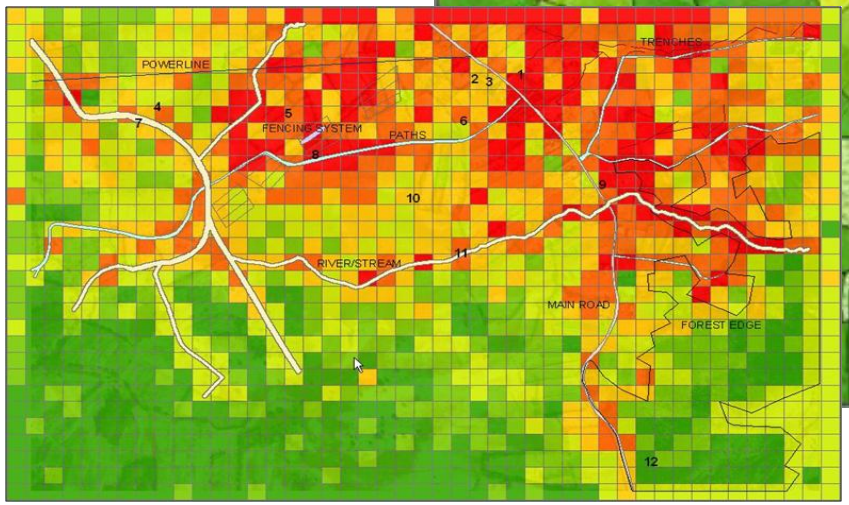
Mine Accidents Records

Potential of space asset integration: ARC, 2003

Parcel-based per-field risk estimation



Risk index



Potential of space assets : navigation & communication

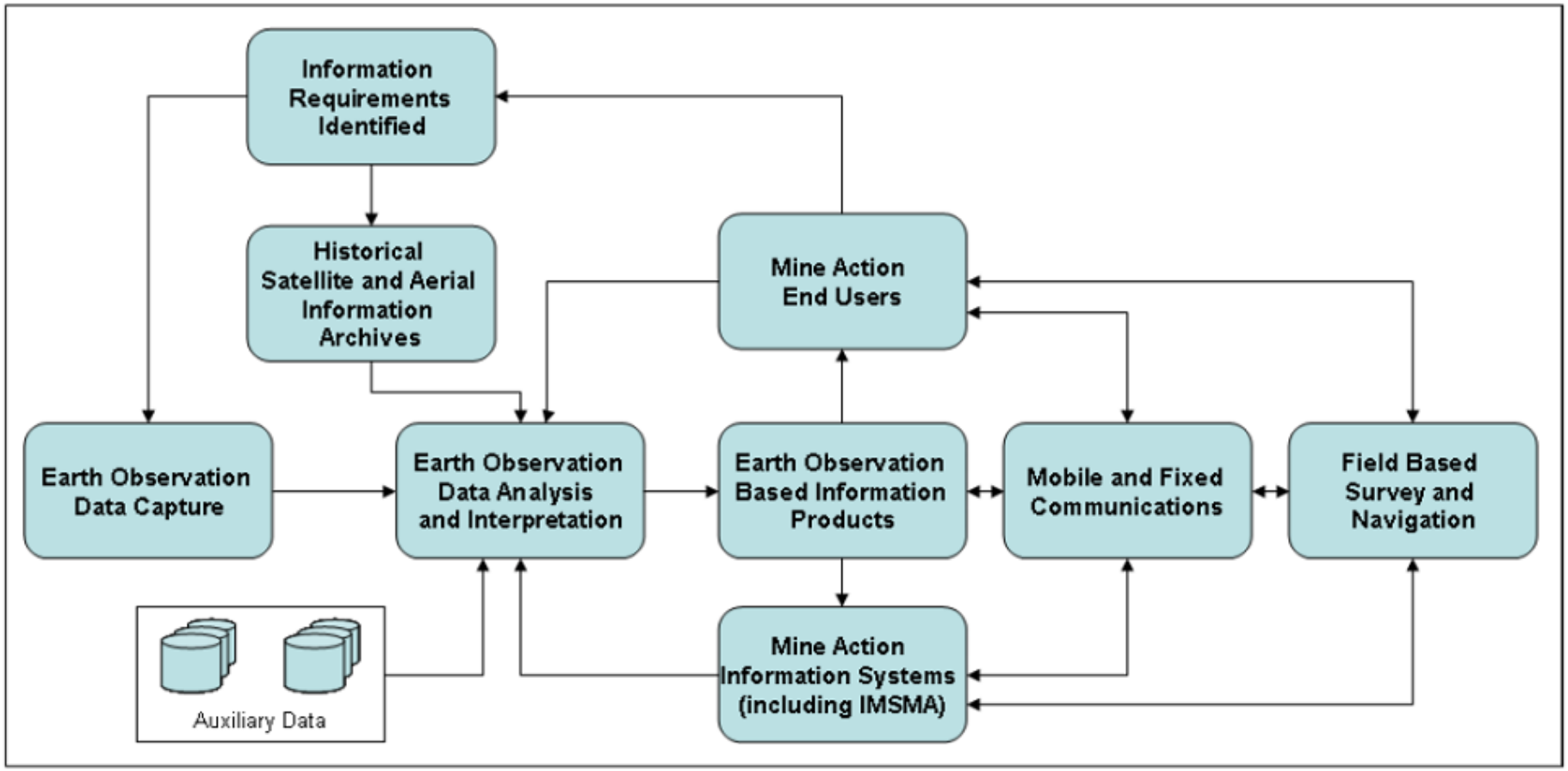
Better reporting (for donors, for learning)

Transfer of maps, more seamless comms with field ops

Georeferencing for GIS integration of:

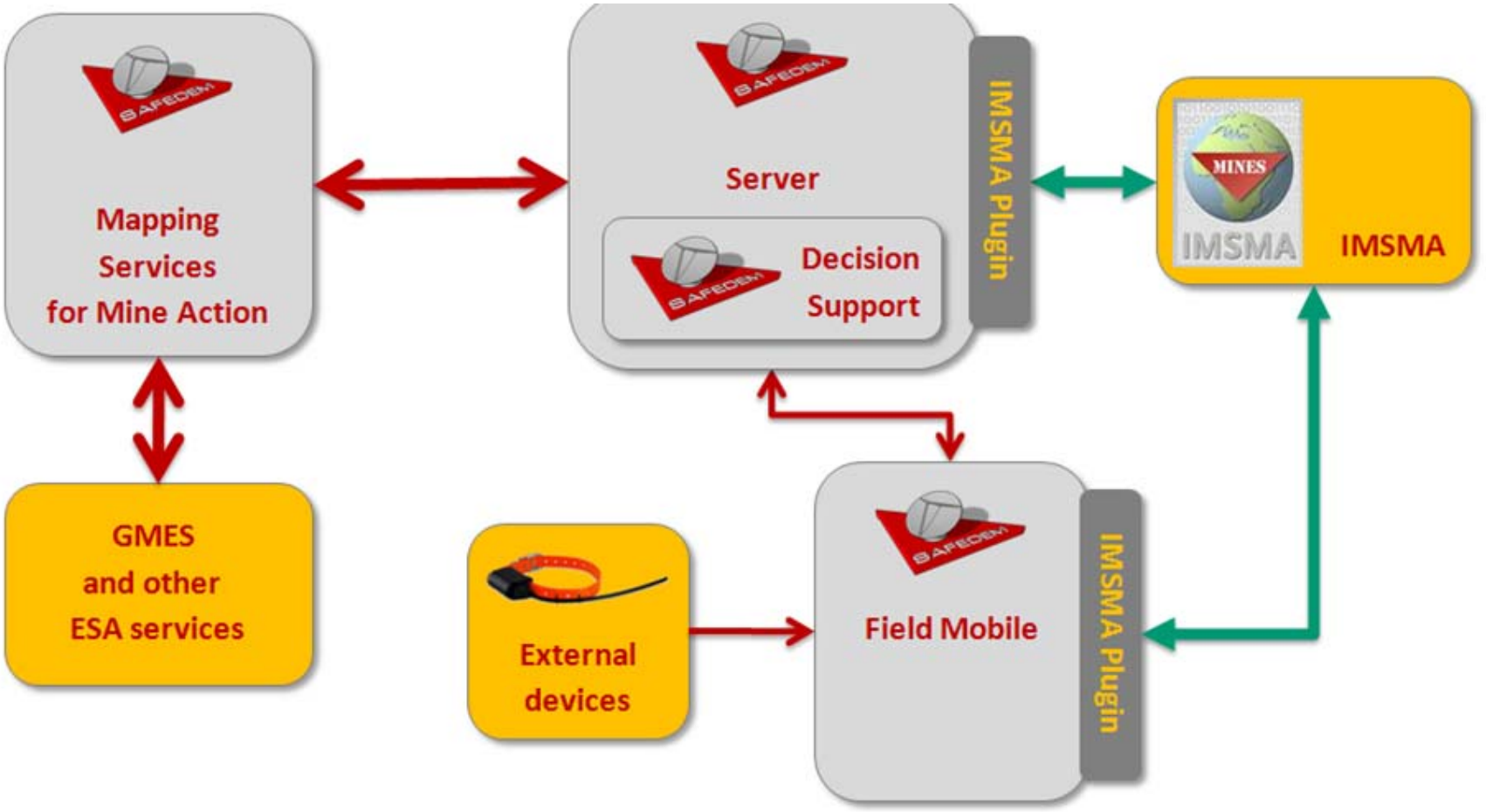
- Interviews
- Field observations
- Stand off detection
- Demarcation
- Clearance

Potential of space assets: land release



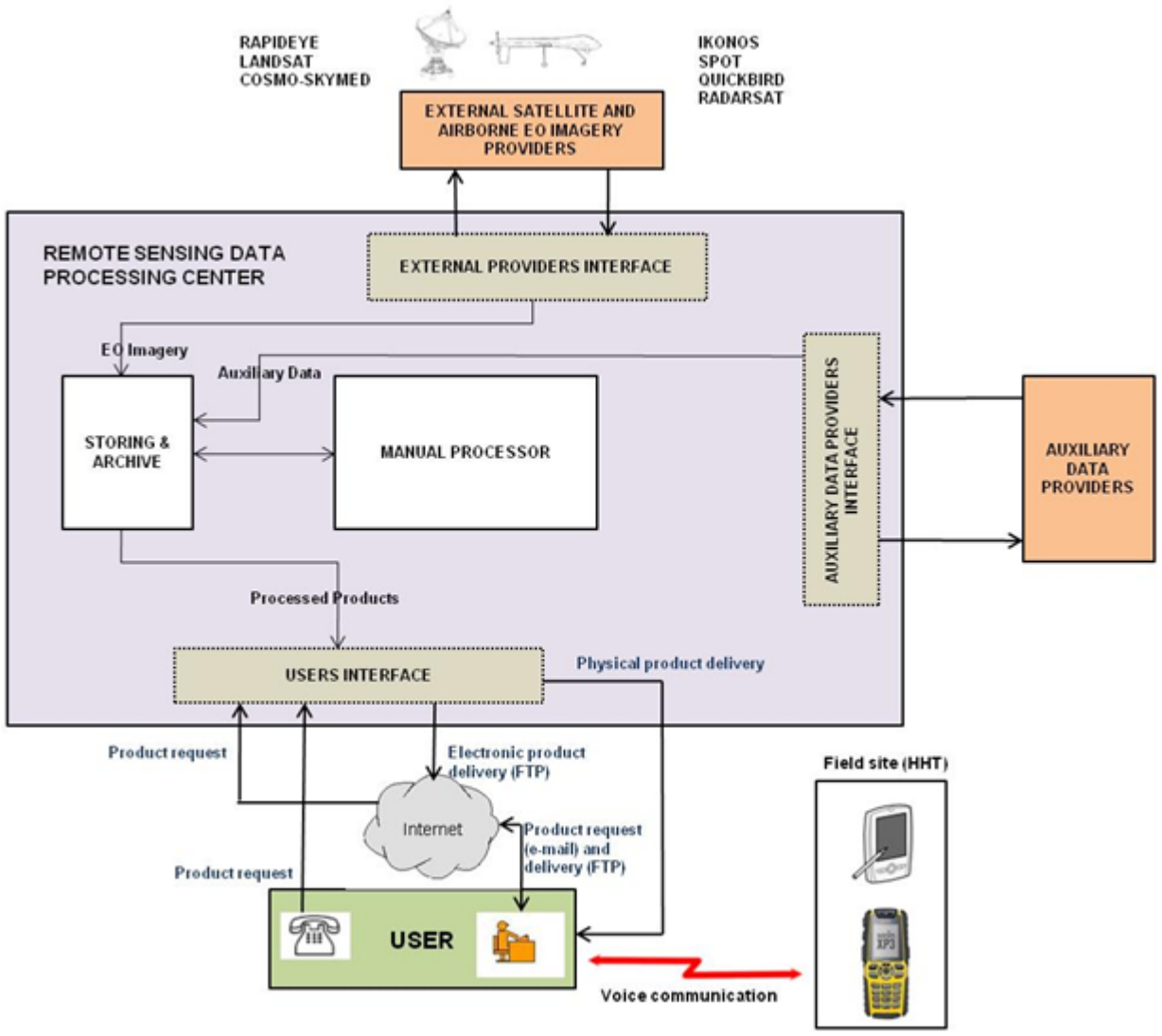
1. Infoterra high level functional SADA concept.

Potential of space assets: land release



2. SAFEDEM high level SADA concept.

Potential of space assets: land release



3: INSA SADA system main blocks

Space Assets for Demining Assistance

Space asset added value:

- **improved socio-economic impact:** planning, prioritization
- **improved land release process:** detection & fusion of indicators, reporting, georeferencing, communication, better maps
- **improved a priori selection of technologies**: complementary, stand-off and/or close-in based on weather, topology, vegetation, season etc.
- **cost reduction:** better procedures, operations

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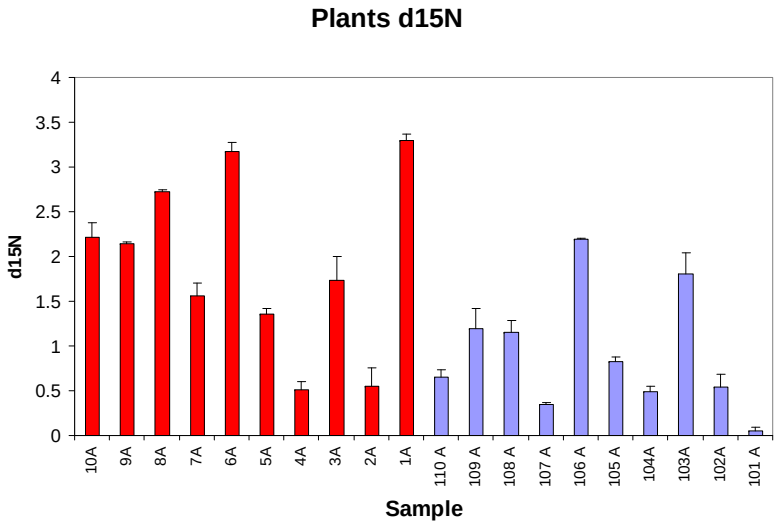
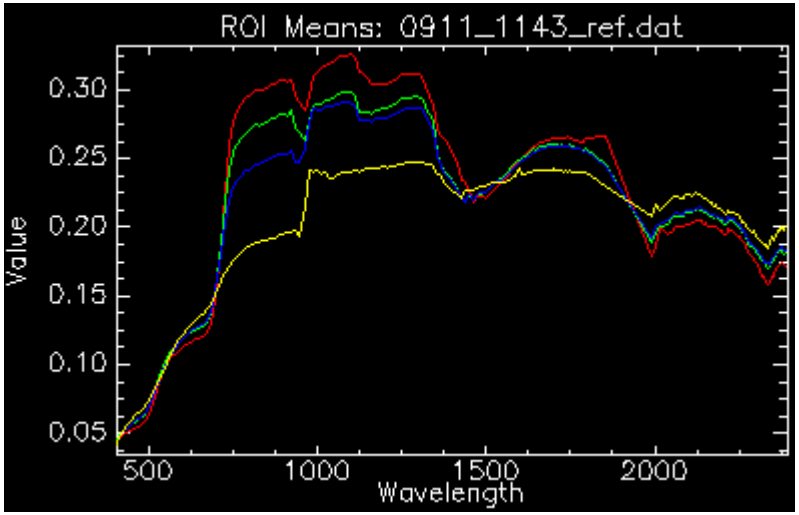
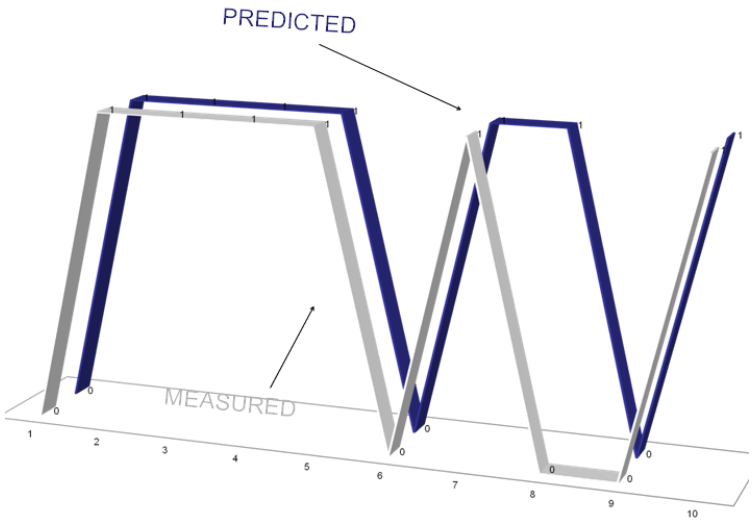
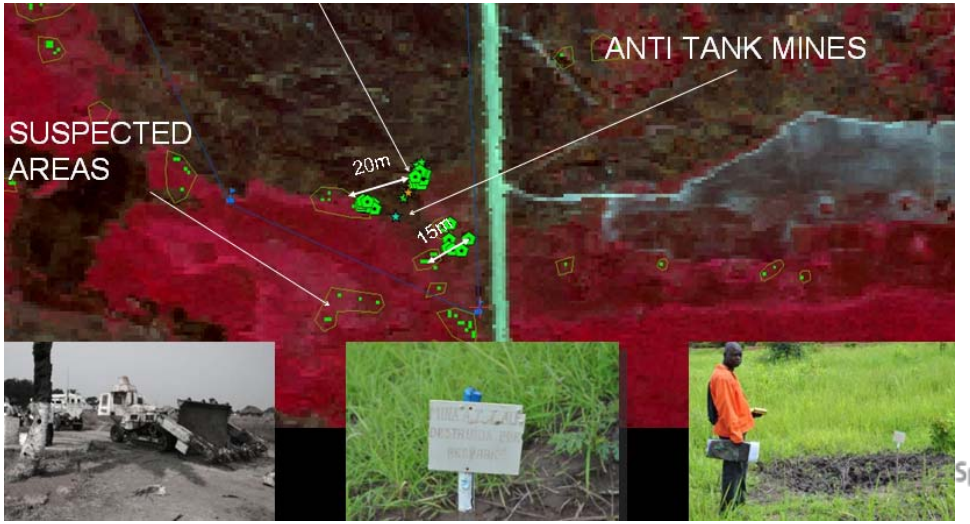
Potential of space assets : GeoMine





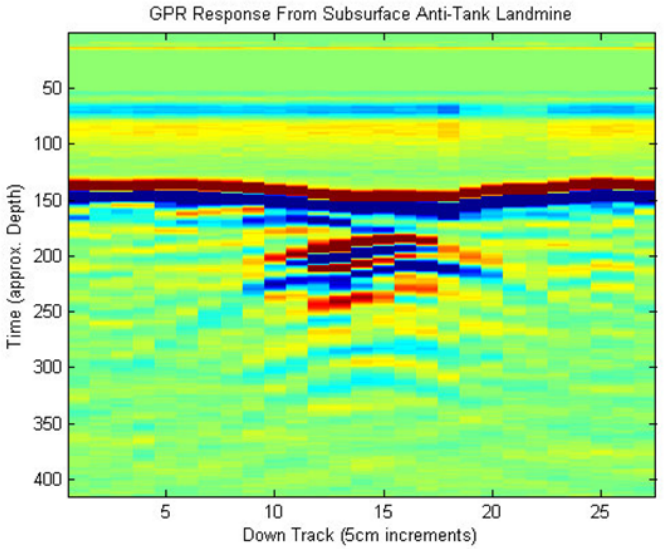




Space Agency

Potential of space assets : direct detection?

- GPR range ~30 cm, 2 km/hr, dry soil
- May be extended to 10 m, 120 km/hr (TU Delft)
- Miniaturization required
- Potential for UAV + DGPS/RTK
- Reliability likely low (<85%)
- Possible additional data source for pattern detection



What space assets can bring you

Satellite navigation

- GPS constellation
  - 15 m, no integrity, no guarantee
- SBAS / EGNOS
  - Satellite based augmentation system
  - 5 m + integrity
- Galileo
  - European constellation (2013)
  - Integrity + guarantee of service
- Galileo + GPS
  - 2 m + improved availability

Figure 21 High Sensitivity GPS performance

Figure 22 High Sensitivity GPS + Galileo performance

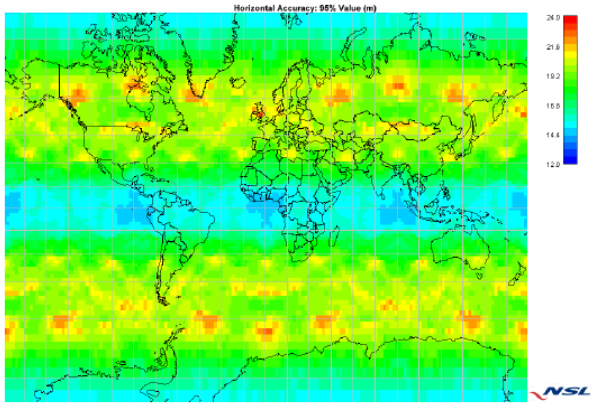


Figure 15 GPS performance

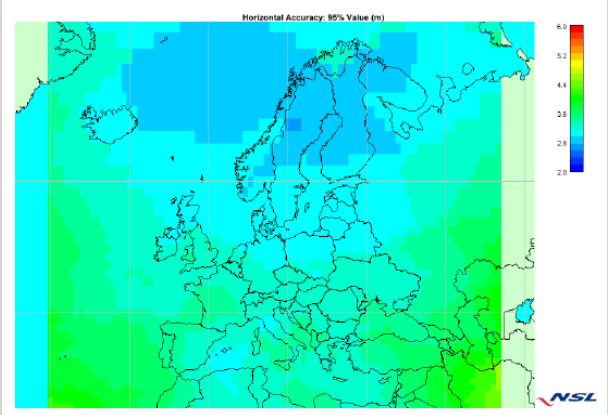


Figure 19 EGNOS performance

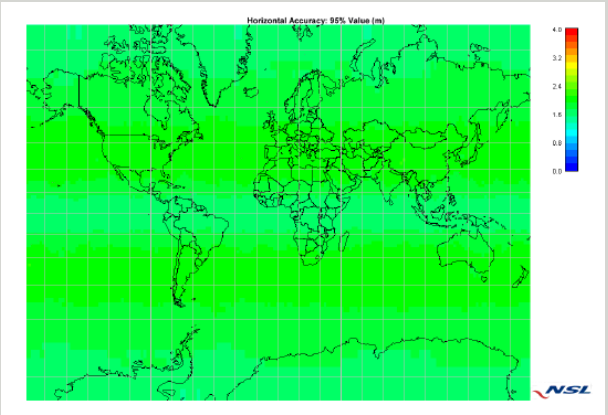


Figure 16 GPS + Galileo performance

What space assets can bring you

Satellite Communication

What space assets can bring you

Satellite Communication

- **Applications**
  - **Remote locations**
  - **Infrastructure breakdown**
  - **Broadcasting**

What space assets can bring you

Satellite Communication

- Applications
  - Remote locations
  - Infrastructure breakdown
  - Secure link
  - Broadcasting
- Services

Services

–Voice, data, video

–Messaging

–Broadband internet

–Broadcast

What space assets can bring you

Satellite Communication

- Applications
  - Remote locations
  - Infrastructure breakdown
  - Secure link
  - Broadcasting
- Services
- Typical systems
  - VSAT

VSAT (Very Small Aperture Terminal)

–Small dish antenna, ~1 m

–Eutelsat, Astra (geostationary)

–Broad band, Ku band, 0.5 MB/s

–Telephony, transactions, internet, maritime communications, video

What space assets can bring you

Satellite Communication

- Applications
  - Remote locations
  - Infrastructure breakdown
  - Broadcasting
  - Secure link
- Services
- Typical systems
  - VSAT
  - BGAN

BGAN (Broadband Global Aera Network)

–Portable terminals

–Internet modem

–Up to 400 Mbit/s

–E.g. Inmarsat

What space assets can bring you

Satellite Communication

- Applications
  - Remote locations
  - Infrastructure breakdown
  - Broadcasting
  - Secure link
- Services
- Typical systems
  - VSAT
  - BGAN
  - Satellite phones & modems

Satellite phones and modems

- Iridium (Low Earth Orbit constellation)
- Thuraya (Geostationary)
- Inmarsat (Geostationary)
- 1 to 144 kbit/s
- voice, data

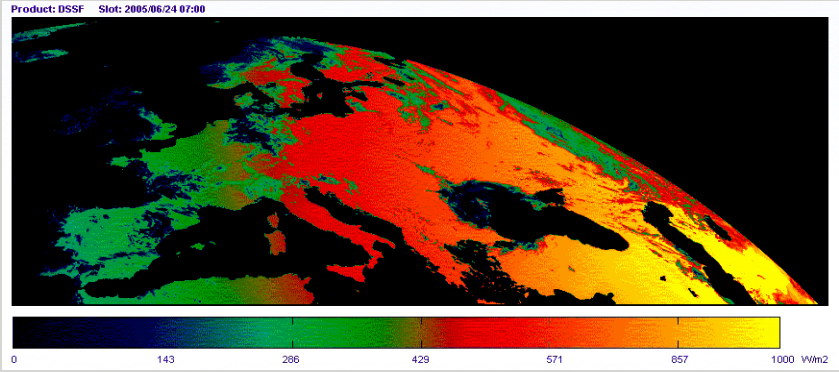
Earth Observation sensors

Earth Observation sensors

- **Geostationary passive sensors**

Geostationary passive sensors

- Altitude 36000 km, fixed position over Earth equator
- Each satellite covers about 1/3rd of Earth
- Visual/Infrared
- High temporal resolution (minutes/hours)
- Low spatial resolution (3-10 km)
- Meteosat/MSG, GOES

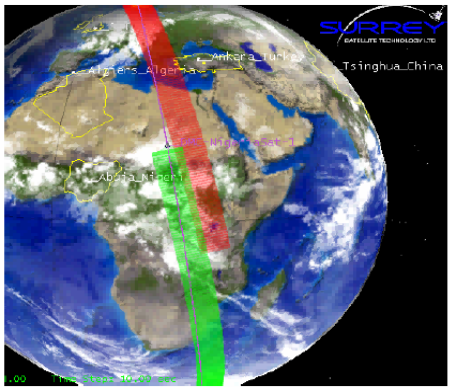


Earth Observation sensors

- Geostationary passive sensors
- Low Earth Orbit passive sensors

Low Earth Orbit passive sensors

– Altitude ~800 km, polar orbit
– Usually providing wide and narrow swath
– Visual / Infrared, L-band (moisture)
– Low temporal resolution (day(s))
– High spatial resolution (0.5 -1000 m)
– Envisat (MERIS), Aqua / Terra (Modis)
DMC, SPOT-VGT, METOP / NOAA (AVHRR)

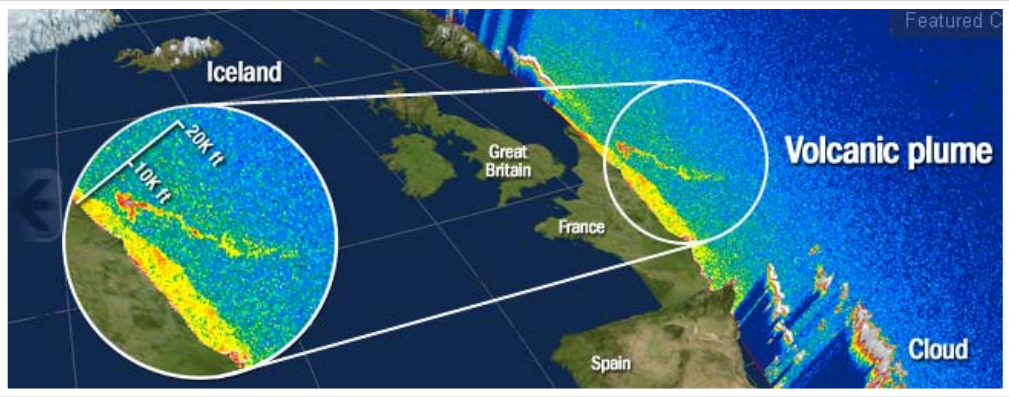


Earth Observation sensors

- Geostationary passive sensors
- Low Earth Orbit passive sensors
- Low Earth Orbit active sensors

Low Earth Orbit active sensors

– Altitude ~800 km, polar orbit
– Radar (X, C band), Lidar, Scatterometer
– Cloud penetration, sea wind, altimetry
– Resolution 1-1000 m
– Low temporal resolution (days / weeks)
– Envisat (ASAR), TerraSAR-X, CosmoSkyMed, Calipso



What space assets can bring you

Earth Observation data

Precipitation / Radiation / Flux

fAPAR, NDVI

Land Surface Temperature

Spatial Resolution	Temporal Resolution	Past	Present	Future

What space assets can bring you

Earth Observation data

Precipitation / Radiation / Flux

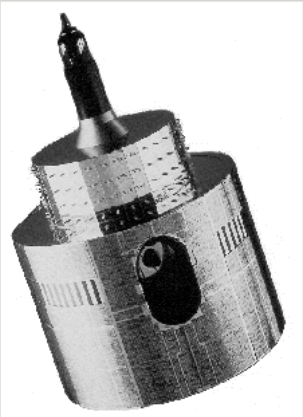
fAPAR, NDVI

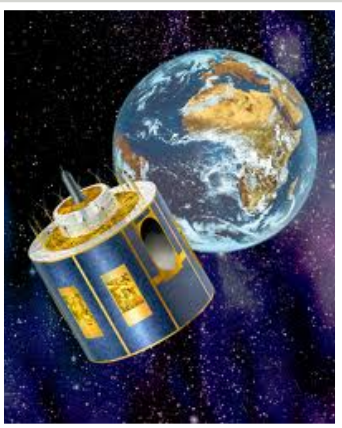
Land Surface Temperature

Spatial Resolution	Temporal Resolution	Past	Present	Future
LOW	HIGH			

Precipitation / Radiation / Heat flux, Evapotranspiration

- Requires VIS, NIR and also (rare) Thermal IR
- High temporal resolution, to remove clouds -> GEO sats.
- 1977 : Meteosat (MVIRI)
- 2004 : Meteosat Second Generation (SEVIRI, 3 km)
- 2013 : Meteosat Third Generation (1 km)





What space assets can bring you

Earth Observation data

Precipitation / Radiation / Flux

fAPAR, NDVI

Land Surface Temperature

Spatial Resolution	Temporal Resolution	Past	Present	Future
LOW	HIGH			
HIGH	LOW			

fAPAR, NDVI

- Requires only VIS & NIR
- High spatial resolution required (30 m – 1 km)
- Terra / Aqua (MODIS)
- SPOT (VGT)
- Envisat (MERIS, 250 m), until 2013
- Sentinel 3 (OLCI), after 2013

What space assets can bring you

Earth Observation data

Precipitation / Radiation / Flux

fAPAR, NDVI

Land Surface Temperature

Spatial Resolution	Temporal Resolution	Past	Present	Future
LOW	HIGH			
HIGH	LOW			
HIGH	LOW			

Land Surface Temperature

- Requires Thermal IR, day and night data
- High spatial resolution
- Terra / Aqua (MODIS), may go out of operation
- Since 1981 : NOAA / METOP (AVHRR), at least until 2020

What space assets can bring you

Earth Observation data

Precipitation / Radiation / Flux

fAPAR, NDVI

Land Surface Temperature

Spatial Resolution	Temporal Resolution	Past	Present	Future
LOW	HIGH			
HIGH	LOW			
HIGH	LOW