Space for Demining
Integrated Applications Promotion
European Space Agency
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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**
- Health
- Energy
- Transport
- **Safety**
- Agriculture
- Environment
- Education, Development
- Entertainment
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

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![Sequence Diagram]

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
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
- 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 (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 (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 practice
(Information Management)

IMSMA: Information Management System for Mine Action, by GICHD
- Data entry & validation
- Data search & reporting
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.
Demining Needs

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

- Information to improve land release without technical survey and more...
- General mapping: geo-referencing of survey results; more representation...
- Change identification within suspected hazard area using remote sensing...
- Collecting & combining indicators of presence or absence of contamination...
- Reduction of unnecessary safety margins
- Assessing impact of floods, landslides and other events that affect management...
- Detailed hazard mapping (from historical data, field reports, feature...)

Legend:
- Very High
- High
- Low
- Very Low
Potential of space assets: land release

Actual situation

Close in detection

Mine free land

Mine land

Desired situation

Close in detection

Air borne detection

Space borne detection

Amount of suspected land addressed
Space Assets for Demining Assistance

**Land Status**
- Loosely defined suspect region
- Priority zones (SHA)
- Hazard zone (CHA)
- Low hazard zone
- High hazard zone (DHA)
- Mine decontaminated zone
- Released zone
- Non Priority zones

**Actions**
- General Mine Action Assessment/Land Impact Survey
- Non-Technical Survey
  - Interviews
  - Collection of records (e.g. by stand-off detection; indicators of mine presence/absence)
- Technical Survey
  - Minefield detection
  - Partial mine detection (probe lanes)
  - Close visual inspection of land
  - Experimental: stand-off detection
- Close-in Detection
- Clearance
  - Individual mine detection
  - Manual deminers with provers, animals
  - Mechanical assistance
  - Verification
- Release & report

**Current Tools**
- Accident reports
- Conflict data
- Environmental data
- Risk analysis
- Socio-economic impact

**Space Assistance**
- EO
  - 1
- EO + NAV
  - 2
  - 5
  - 6
- EO
  - 3
- EO + NAV
  - 4
  - 7
  - 8
- NAV
  - 7
  - 8
  - 9
- European Space Agency
Potential of space assets: indirect indicators
Potential of space assets: SMART

Stand-off Detection: SMART

Legend:
- High: 171
- Low: 0
- Degree of danger

Legend:
- High: 130
- Low: 0
- Degree of confidence

Legend:
- High: 130
- Low: 0
- Degree of confidence

Legend:
- High: 171
- Low: 0
- Degree of danger

Legend:
- Areas outside the scope of SMART
- Demined areas (MIS, 2001)
- Areas for which we have data
- Areas for which we have no data

SMART integrated in ArcGIS
- Edge line detector
- BF classifier
- Minimum distance distance
- Danger maps
- Gabor filters
- Interferometric
- Power line
- Pauli
- Format converter
- Palatentic
- Bushes / hedges
- IDL

Road tracker
- Matlab
- Data fusion
- M-S interceptors
- COTS
- Per-region Classification
- Change Detection
- PC
- Recognition
Potential of space asset integration: ARC, 2003

Parcel-based per-field risk estimation

Risk index
Potential of space assets: GeoMine

Plants $d^{15}N$

ROI Means: 0911_1143_ref.dat

Sample

SUSPECTED AREAS

ANTI TANK MINES

Space Agency
Georeferencing for GIS integration of:
- Interviews
- Field observations
- Stand off detection
- Demarcation
- Clearance

Potential of space assets: navigation & communication

Examples:
- Navigation
- Communication
- GPS
- Photos
- Bonoculars
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
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
Potential of space assets

*Spaceborne Earth Observation data*
- Mapping support (input to GIS)
- Planning of mine action resources (land cover, humidity, slope)
- Prioritization (socio-economic impact, agricultural value, infrastructure etc.)
- Risk mapping (indicators of mine presence/absence) and land release support

*Satellite Navigation*
- supports the navigation of UAV/aircraft in zones of investigation.
- Support survey & clearance teams for georeferencing and geofencing.

*Satellite Communication*
- Enable the transfer of collected data to a remote processing centre
- Support to global deployment of the service.
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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