Space-based technology for Water

ASI Activities and Achievements

Vienna, 17 June 2015

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Outline

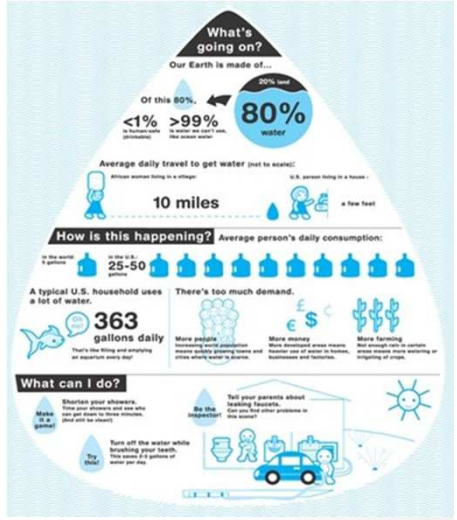
- The setting
- Water in Space:
  - Detecting Technology
- Water for Space
  - Space analogue and Recycling Technology
- Space for Water:
  - Resource
  - Concern
- Conclusions

- **Abstract**: The presentation provides a comprehensive paramount of ASI activities in the field of water management. The field of this topic is very challenging and it has different perspectives in terms of technologies on board of space-based platform for detection and monitoring of water on the Earth, on the atmosphere and on other celestial bodies (*e. g.* Mars, asteroids, Moon, etc.). The monitoring tasks involve also development of information technology elements including web-based platforms and satellite data storage, processing and sharing techniques. ASI has been an active player and thoughtful partner in many bi-lateral and multilateral agreements for supporting this field of technology. This presentation shows developments of technology by ASI as stand-alone and as partner of joint international cooperation. The projects are also developed for national purposes with other national stakeholders and within international cooperation framework, such as GEOSS, CEOS *et similia fora*. ASI developed an advanced constellation of 4 SAR satellites, COSMO-SkyMed, which has, inter alia, mission to monitor costal and maritime awareness of Mediterranean and Oceanic environments. In addition, Italian industry have developed several water management applications providing related benefits to other national contexts in case of disasters as pre- and post-management. In conclusion, presentation ends with the coming perspectives on this field in terms of further technologies development, coming dissemination and promotion activities (*e. g.* EXPO Milano 2015) and further related international cooperation.

The Setting

- Water is a natural element enabling life
  - 80% of our Planet is H_2O
- Water is a commodity enabling growth
  - dependable water supplies

  contribute to GDP growth: 78%
- Water is a private good enabling sanification
  - Water market exists
- Water is a public utility enabling community
  - Infrastructures are public goods
- Water is a fundamental human right
  - Water enables eradication of poverty



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Water in Space

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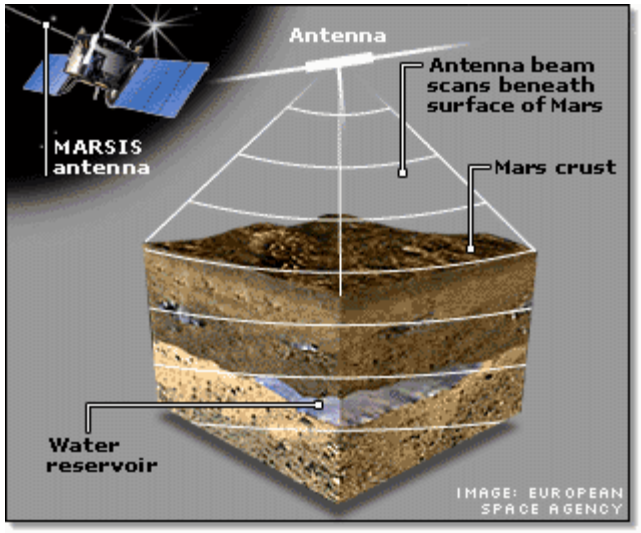
- It is a low frequency, nadir-looking pulse limited radar sounder and altimeter with ground penetration capabilities, which uses synthetic aperture techniques and a secondary receiving antenna to isolate subsurface reflections
- It is composed of 3 subsystems:
  - The antennas
  - The RF equipment (transmitter and receivers)
  - The digital electronics
- In its standard operating mode, the instrument is capable of making measurements in 1 MHz wide bands centered at 1.8, 3.0, 4.0 and 5.0 MHz



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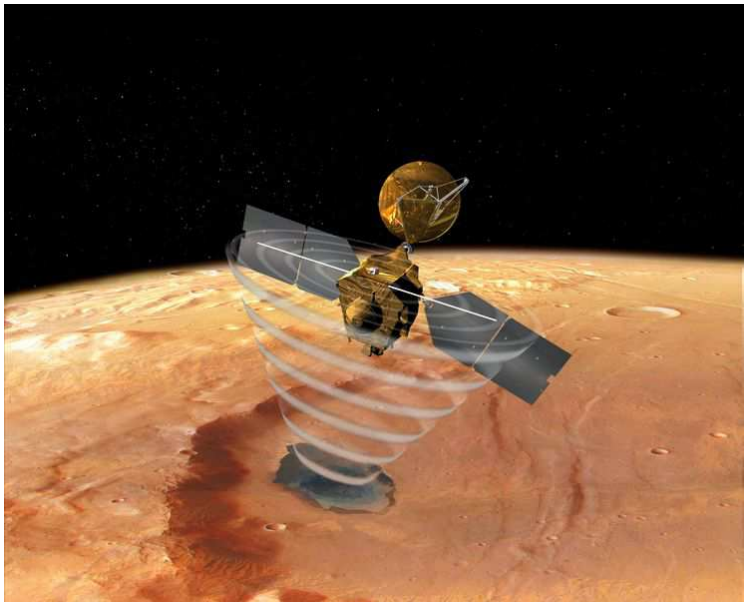
- MARSIS is a joint ESA-US-ASI Mars Express science instrument
- It is an element o ESA Mission – Mars Express launched from Baikonur, Kazakhstan in June 2003 still orbiting around Mars

Water in Space

Mars **SHA**llow **RAD**ar sounder

- It seeks liquid or frozen water in the first few hundreds of feet - up to 1 km - of Mars' crust
- It probes the subsurface using radar waves using a 15-25 MHz frequency band in order to get the desired high depth resolution
- It has a horizontal resolution of 0.3-3 km and 15 m vertically
- It complements the MARSIS instrument on Mars Express, providing lower penetration capabilities - hundred meters - but much finer resolution - 15 m – un-tapered – in free space



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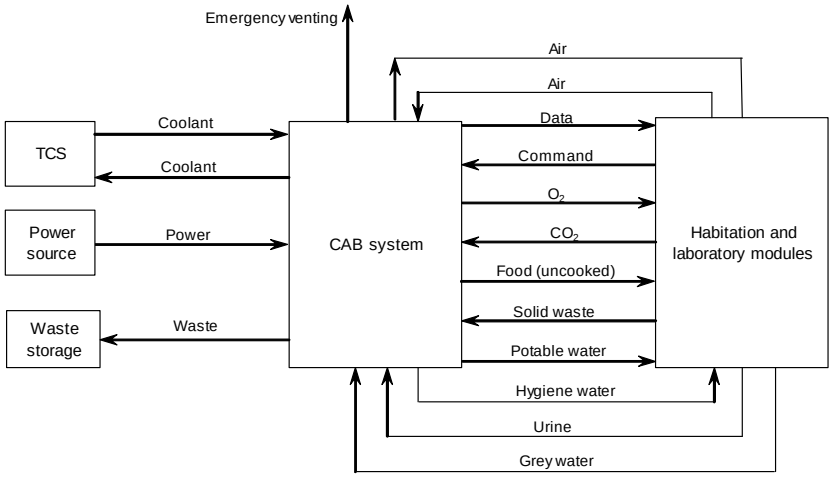
- It embarked on the Mars Reconnaissance Orbiter probe – NASA Mission in 2005
- It is developed under the responsibility of ASI and provided to NASA - JPL
- The exploitation of the data has a joint Italian/US team

Water for Space

- **CAB** (*in Italian: Controllo Ambientale Biorigenrativo*) project aimed to study and realize a controlled biological system for the space exploration
- Its technological development comprehends priorities concerning with:
  - Water treatment and control;
  - Water and air monitoring;
  - Air purification
- Water component is a key-element of CAB conept

© ASI, CAB Integrated technologies



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Space for Water

- Space-based technology enhances water management as a **resource** and a **concern**:
  - Monitoring pollution
  - Planning land uses
  - Forecasting weather conditions
  - Disaster management
- In these regards ASI developed

a dual-vocation SAR constellation, COSMO-SkyMed, operationally integrated with other constellations

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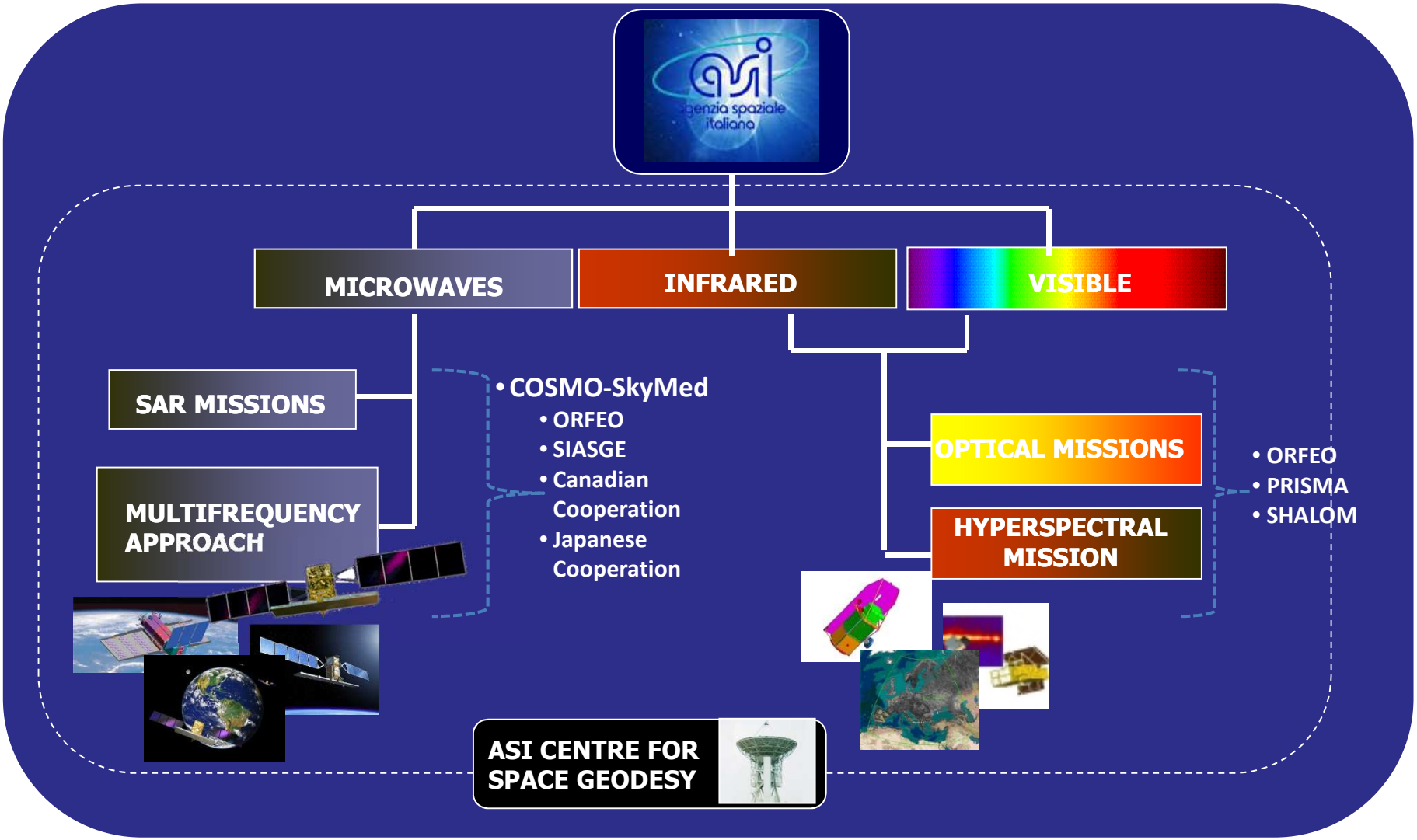
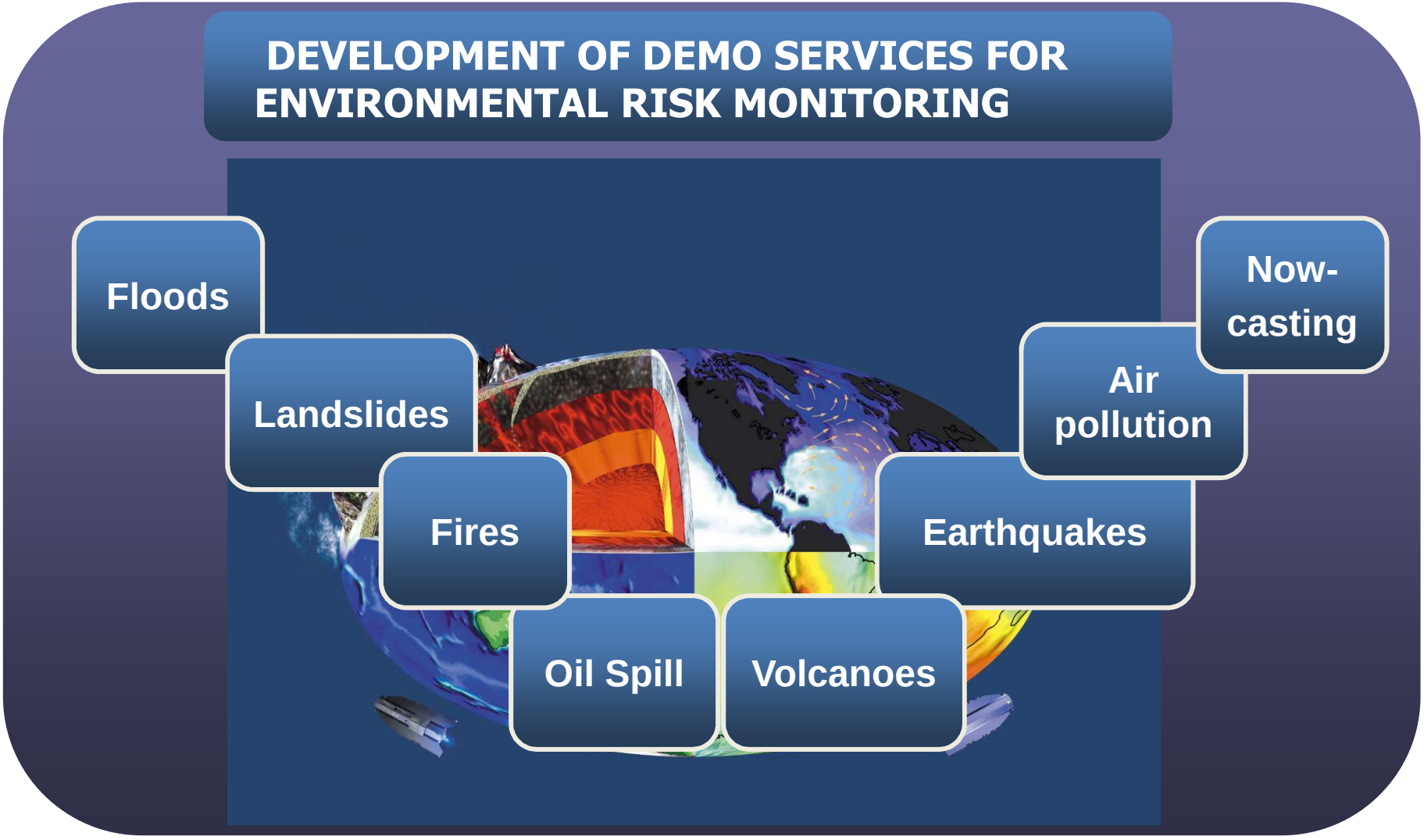
Space for Water



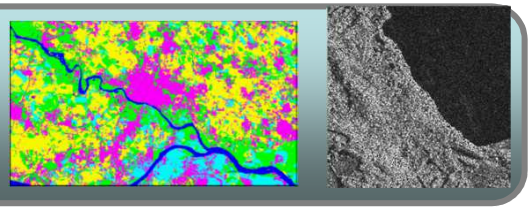
Space for Water



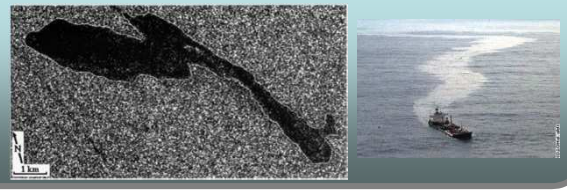
Space for Water

- Water concerned pilot projects are:

Floods — **OPERA**
Civilian Protection against Floods



Oil Spill — **PRIMI**
Pilot Project for Hydrocarbon Sea Pollution

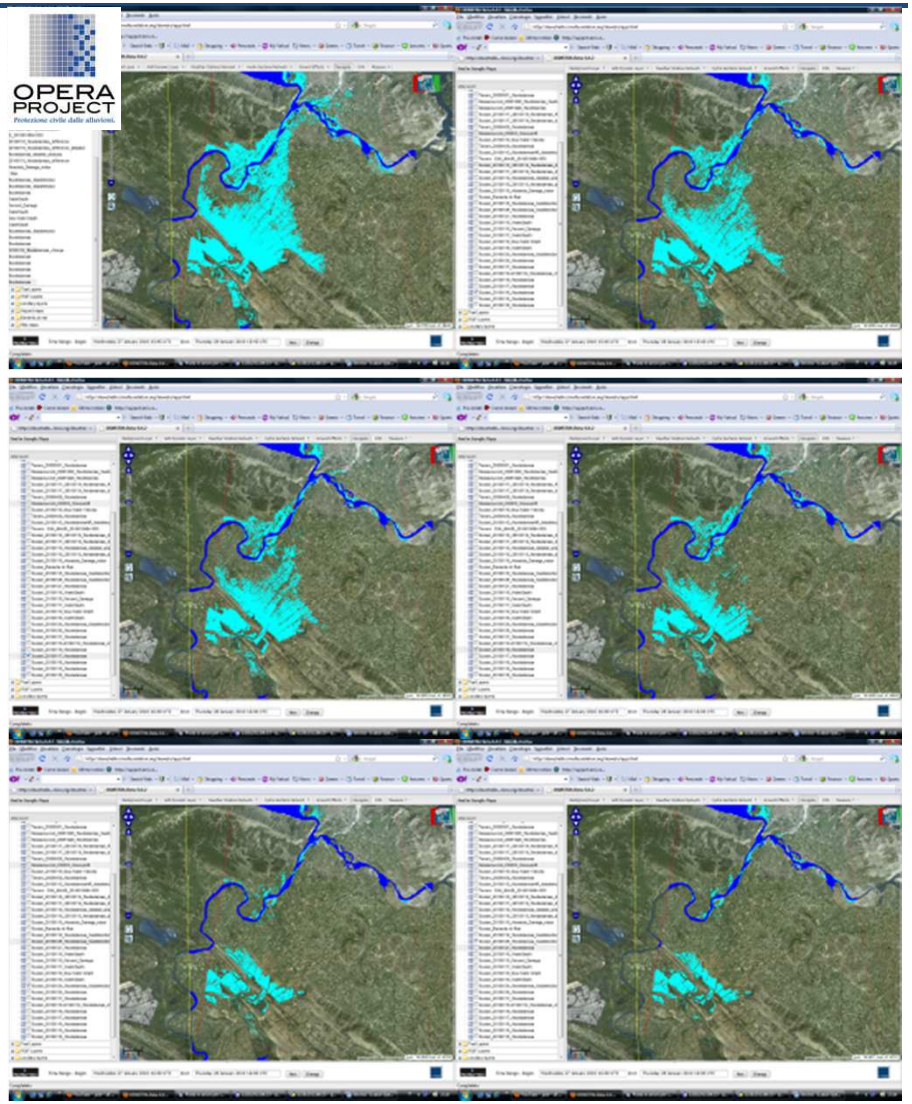


Now-casting — **PROSA**
Precipitation evaluation by integration of Meteo-models, Satellite and Ground-based Data

- ASI and an extensive network of centers of excellence, universities, industrial players and relevant interest-holders catalyzed needs to have a comprehensive national capability in the field of EO from asset development to value-added services

Space for Water

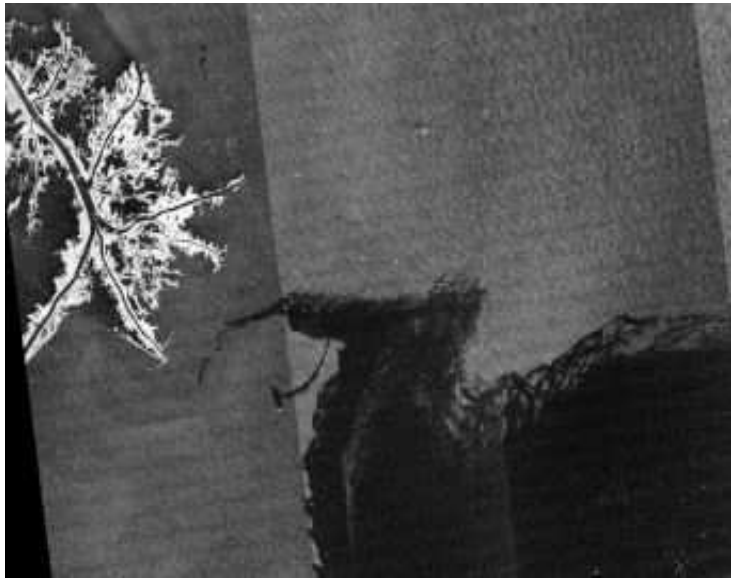
- **OPERA OPerational Eo-based RAinfall-runoff forecast**
- The End User is the Civil Protection Department
- The enterprise team is led by the COS(OT) Consortium of enterprises and scientific partners
- Multi-temporal acquisition of CSK data allows to monitor dynamics and to validate hydrodynamic models for post-disaster phases



COSMO-SkyMed Data Acquisition from 10.01.2010 to 25.01.2010

Space for Water

- **PRIMI**, promoted by the Italian Space Agency, aims at developing and implementing a modular system for the operational monitoring of marine pollution caused by hydrocarbon spills
- The system uses multi-platform SAR and optical data (mainly ERS, ENVISAT, COSMO/SkyMed, MODIS and MERIS) for slick detection



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- The system also provides data on wind, waves and currents, as well as ship data inferred from the satellite imagery
- It assesses the location and characteristics of oil slicks, it forecasts their position and feature change and it stores and disseminate data relevant to environmental remediation

Space for Water

- **PROSA** – Prodotti di Osservazione Satellitare per Allerta Meteorologica (*in English Satellite Observation Products for Meteorological Alert*) is funded by ASI
- Its main project's objectives are: the design, development, testing and demonstration of a prototype system dedicated to the innovative dynamic characterization of meteorological parameters at ground
- It is based on combined use of EO satellites data, *in situ* data and other technologies
- Its main end-user is the Italian Department of Civil Protection in managing the risks associated with floods and hydro-geological hazardous events

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Conclusions

- Space for water implies multidisciplinary expertise that needs of front-runner technologies and data availability
- Development of new cases enhances economies of scale of EO system: international cooperation is envisaged
- Exploitation of pilot projects for new cases boosts economies of scope: multilateral cooperation is beneficial

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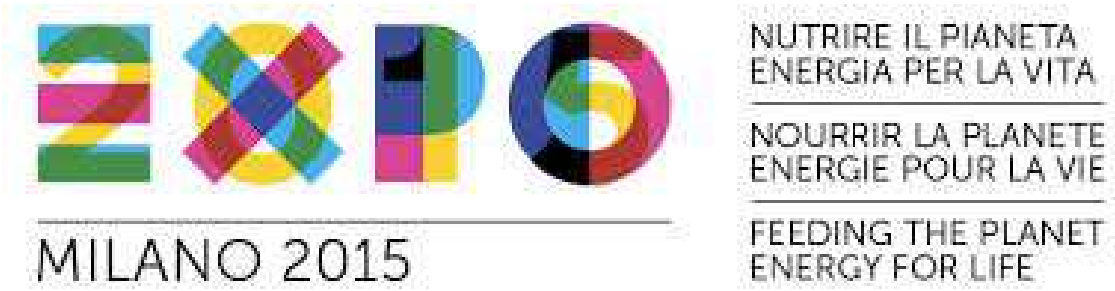
Conclusions

Space *vs* Water	ASI Capability & Functionality	Future Steps
Water in Space	Radar technologies	Spin-off for terrestrial usages
Water for Space	Life Support	Long human space missions Spin-off for space analogues
Space for Water	Data Integration	Pooling and Sharing activities

- Water stressed areas shall benefit of space technology
- Relief of water concerns enables a more comfort socio-economic growth
- Better water management reduces inequality among States
- Space-based technology hugely enables inclusive growth

Space and Water



Thanks.

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