INTOGENER

INTegration of EO data and GNSS-R signals for ENERgy applications

AO/1-6124/09/NL/US – Feasibility study

Laia Romero, Starlab

ARTES Applications Workshop, ESTEC, 6 April 2011

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Project Concept and Background

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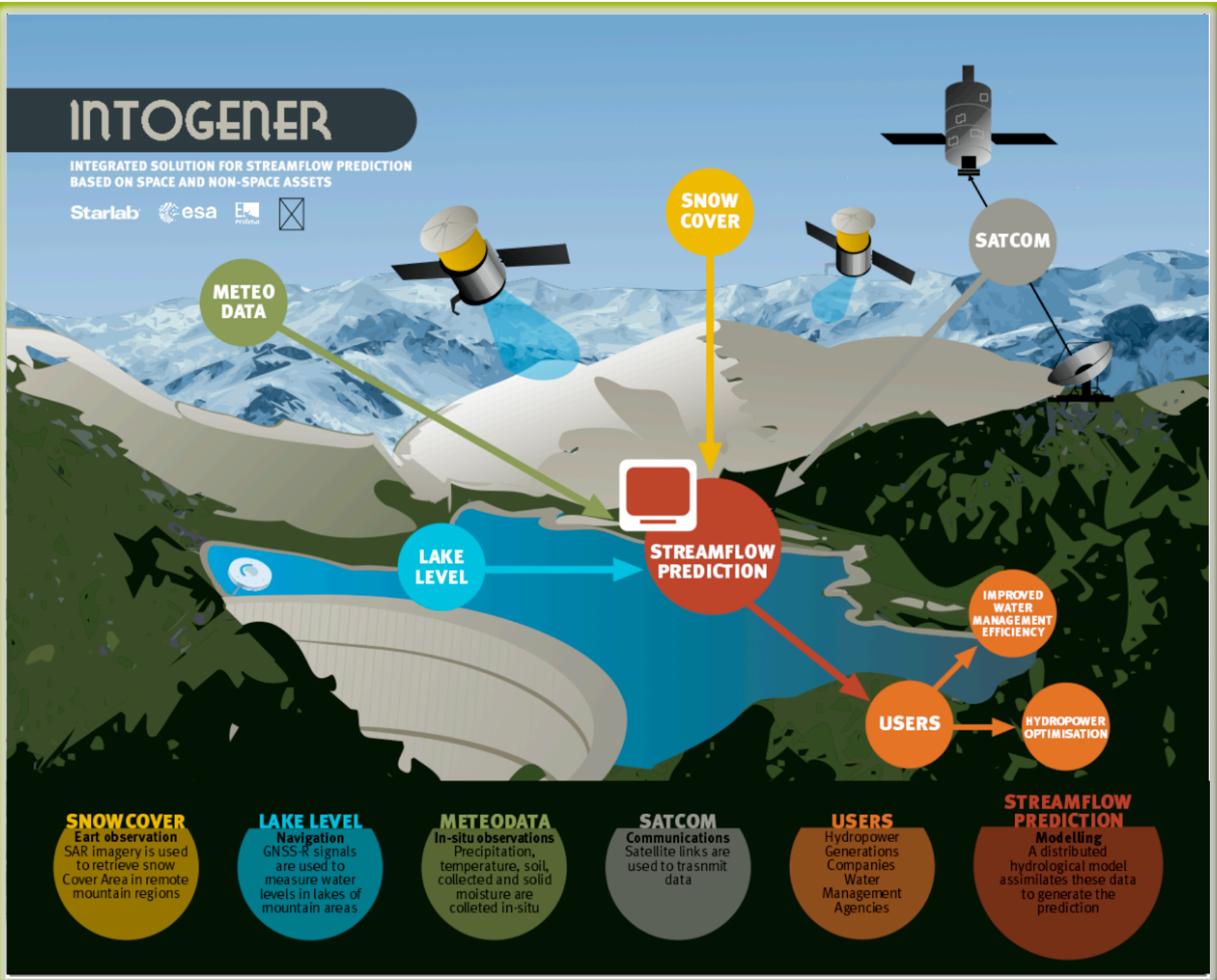
Water flow prediction service based on physical observations at operational **forecasting points**, and aimed at **hydro power** companies

- The INTOGENER project analyzes the feasibility to combine and integrate different service assets:
  - Satellite-based EO data
  - In situ information
  - Satellite communication
  - Assimilation of these data into a distributed hydrological model

OUR GOAL: overcome current constrains to count on reliable water flow predictions in **remote mountain areas of difficult access**

Actors involved

- **ENDESA** as user and stakeholder:
  - Support on user requirements, logistics for field campaigns and project follow-up
- **Starlab** as project coordinator, remote sensing expert and service provider
- **PUC** as subcontractor and modeller
- **ESA** as co-financing entity, advisor for technical aspects and dissemination


INTOGENER
INTEGRATED SOLUTION FOR STREAMFLOW PREDICTION
BASED ON SPACE AND NON-SPACE ASSETS
Starlab
esa
SNOW COVER
SATCOM
METEO DATA
LAKE LEVEL
STREAMFLOW PREDICTION
IMPROVED WATER MANAGEMENT EFFICIENCY
USERS
HYDROPOWER OPTIMISATION
SNOW COVER
Eart observation
SAR imagery is used to retrieve snow Cover Area in remote mountain regions
LAKE LEVEL
Navigation
GNSS-R signals are used to measure water levels in lakes of mountain areas
METEODATA
In-situ observations
Precipitation, temperature, soil, collected and solid moisture are colleted in-situ
SATCOM
Communications
Satellite links are used to trasnmit data
USERS
Hydropower Generations Companies
Water Management Agencies
STREAMFLOW PREDICTION
Modelling
A distributed hydrological model assimilates these data to generate the prediction

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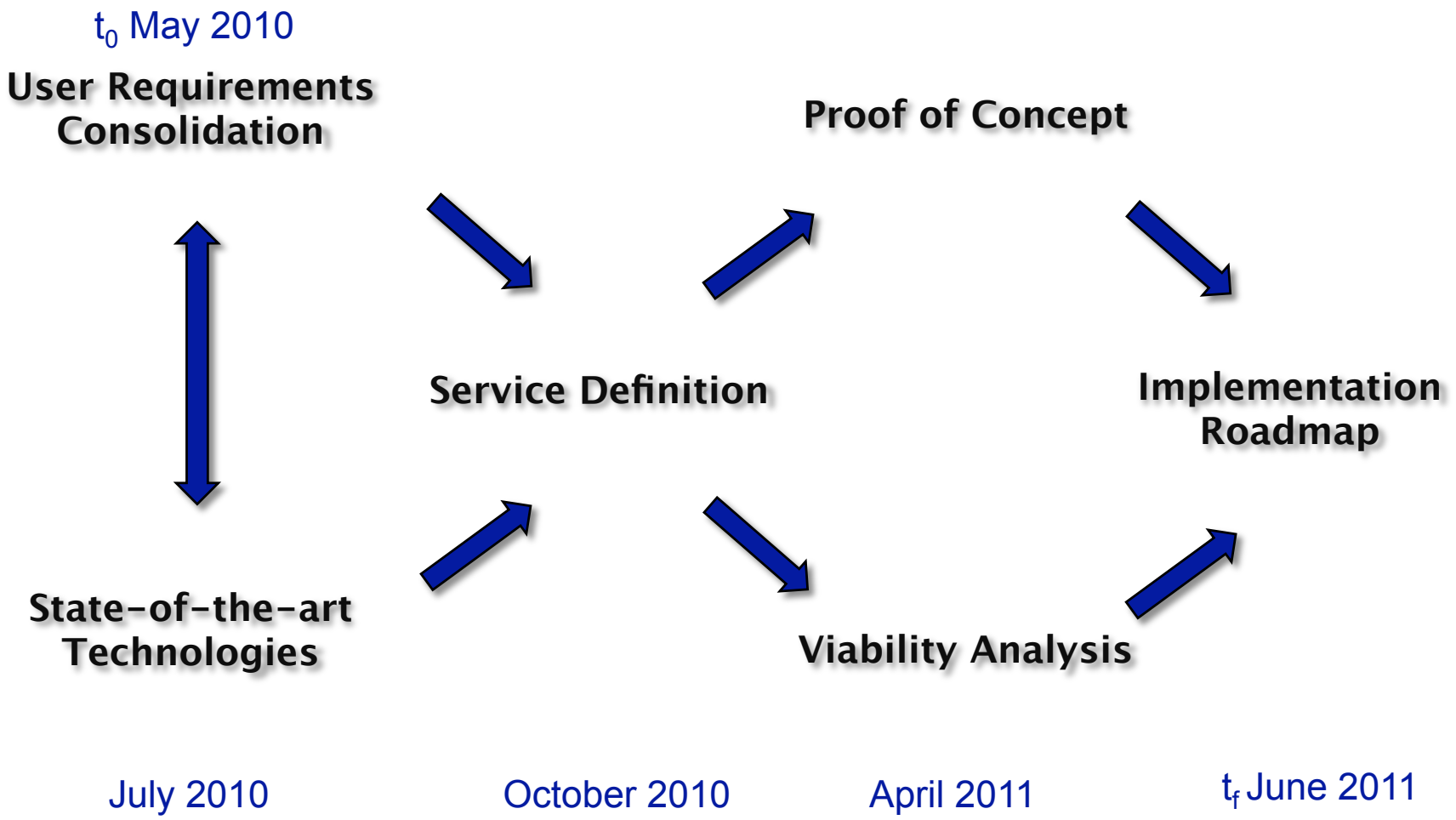
Summary of Activities

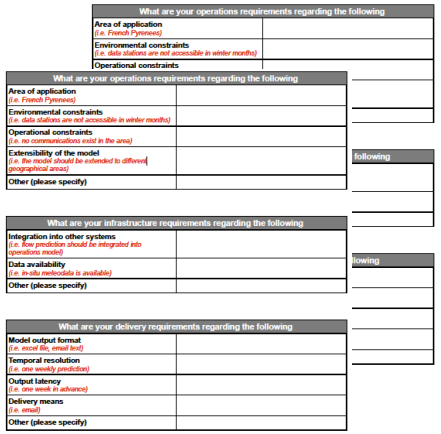
Task overview



User requirements

Questionnaires and Interviews to major stakeholders

- **Company Profiles**
- **Current use of INTOGENER-related technologies**
- **User needs** → *Current constrains of flow prediction practices*
  - Endesa needs
    - Snow melting flow model weaknesses
    - Short term prediction methodology weaknesses
    - Needs for the new prediction outcome
  - Needs of other stakeholders



What are your operations requirements regarding the following	
Area of application (i.e. French Pyrenees)	
Environmental constraints (i.e. data stations are not accessible in winter months)	
Operational constraints (i.e. no communications exist in the area)	
Extensibility of the model (i.e. the model should be extended to different geographical areas)	
Other (please specify)	

What are your infrastructure requirements regarding the following	
Integration into other systems (i.e. flow prediction should be integrated into operations model)	
Data availability (i.e. in-situ meteodata is available)	
Other (please specify)	

What are your delivery requirements regarding the following	
Model output format (i.e. excel file, email text)	
Temporal resolution (i.e. one weekly prediction)	
Output latency (i.e. one week in advance)	
Delivery means (i.e. email)	
Other (please specify)	

- **User requirements** → *Ideal properties of a flow prediction service product*
  - Operations
  - Infrastructure
  - Delivery
  - Validation
  - Specific Endesa requirements with regards INTOGENER

User requirements

- Surface runoff predictions is a MUST for all participant stakeholders
- Physical variables in modelling systems used by organizations:

- The more observations, the more trustworthy the prediction is
- Distribute modelling is the desired trend
- Operational snow parameters are challenging for all participant stakeholders
- Extendability of one model is also challenging for all companies involved
- Integration with an operations system is a MUST
- Minimum service description:
  - Weekly to daily forecasts, Weekly snow update, Text output, 3-day prediction, 80% accuracy, e-mail notifications

State of the art Technologies

User Needs

System Concept

State of the art in

Hydrological modeling ✔
Snow measurements ✔
Lake level measurements ✔
Meteorological measurements ✔
Soil moisture ✔
Satellite communications ✔
Digital elevation maps ✔
Land surface temperature ✔

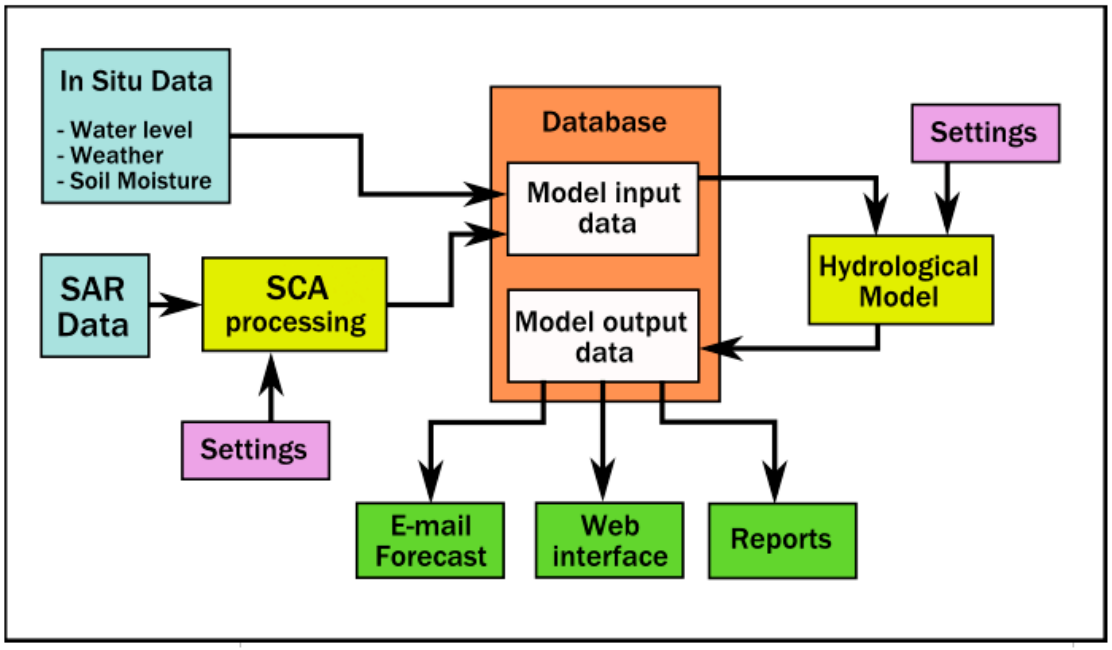
Trade-off analysis

Technology selection

Service Definition

User Requirements (SHALL, SHOULD, MAY, WILL) + SoA Technologies = **SERVICE CAPABILITIES**

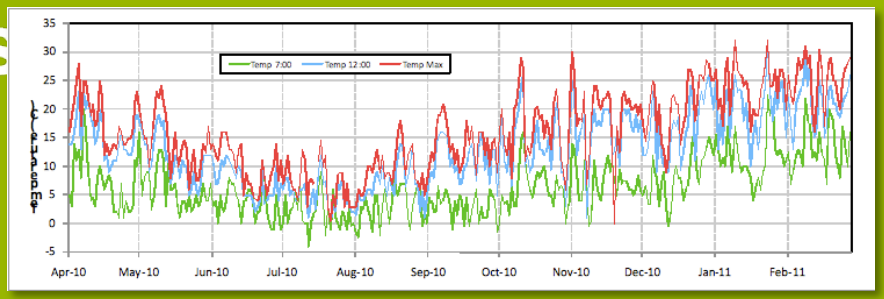
- **Service specifications**
- **System (and subsystems) Requirements**
- **System Architecture**
- **Validation Plan**

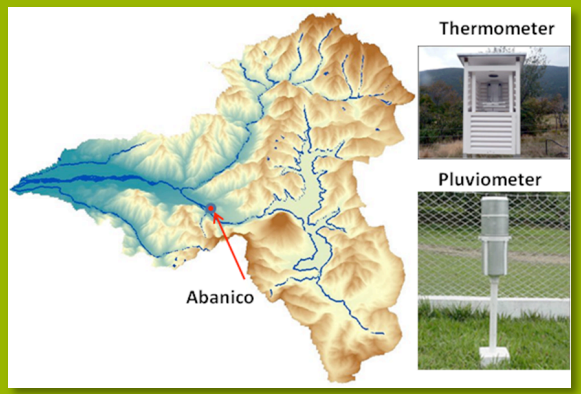


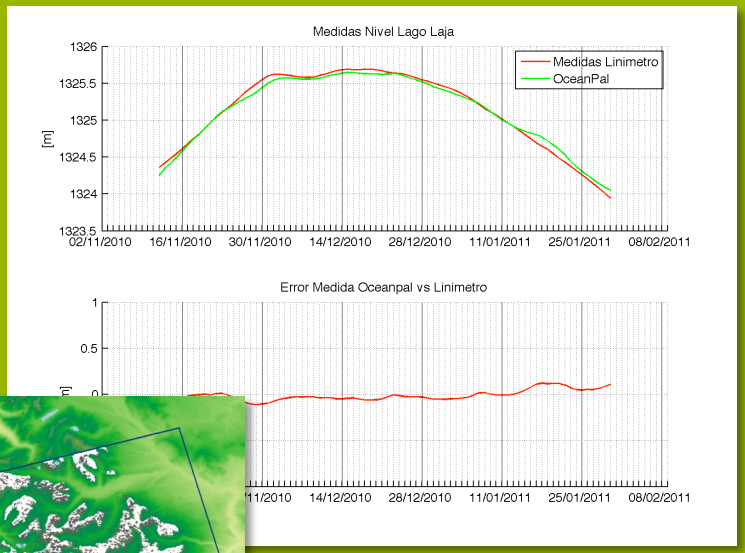
Proof of concept

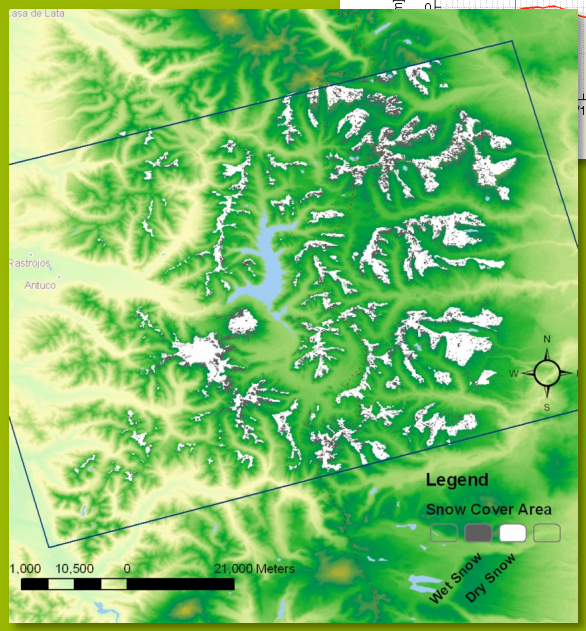
Feasibility of the service concept in the Laja Basin, Chile

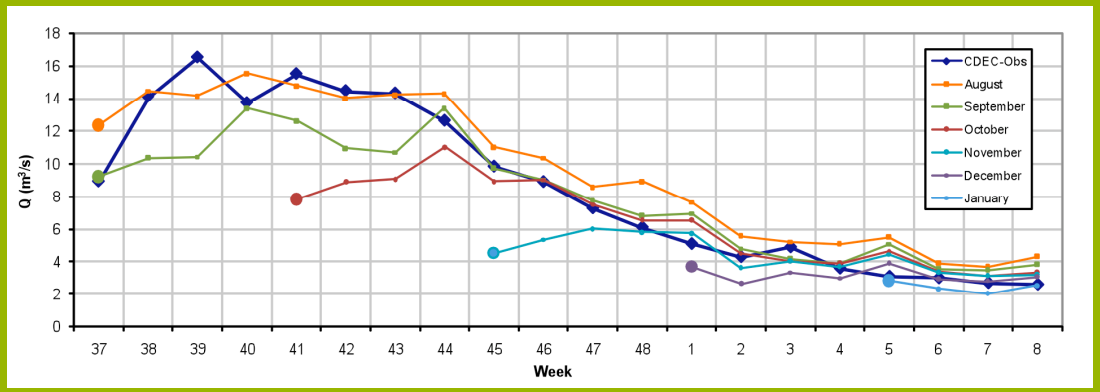
- Use of a GNSS-R instrument (Oceanpal) for in-situ water level
- Use of existing weather stations for collection of temperature, humidity, rainfalls and solar radiation..
- The acquisition of a set of SAR images and their processing to compute the SCA at 3/4 different date of the melting season (1 summer + 3/4 melting season).
- The assimilation of 1) In-situ data from Oceanpal, 2) SCA, 3) climatological weather data into a hydrological model for the prediction of water flow.
- Validation of results

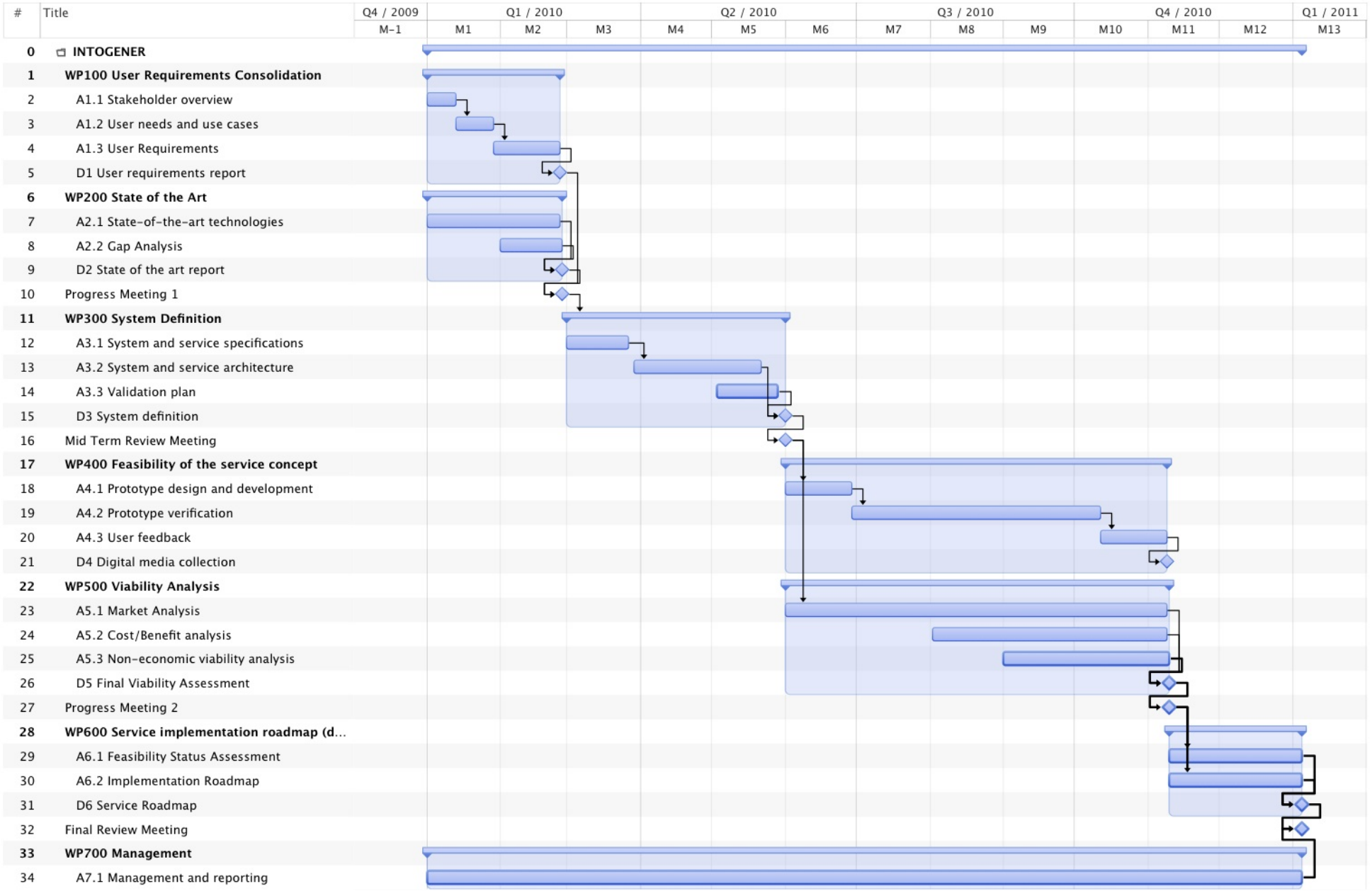

Temp 7:00
Temp 12:00
Temp Max
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10
Jan-11
Feb-11


Thermometer
Pluviometer
Abanico


Medidas Nivel Lago Laja
Medidas Linimetro
OceanPal
[m]
02/11/2010
16/11/2010
30/11/2010
14/12/2010
28/12/2010
11/01/2011
25/01/2011
08/02/2011
Error Medida Oceanpal vs Linimetro


Legend
Snow Cover Area
Wet Snow
Dry Snow
1,000
10,500
0
21,000 Meters


Q (m³/s)
Week
CDEC-Obs
August
September
October
November
December
January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Title
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M9
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M11
M12
M13
0 INTOGENER
1 WP100 User Requirements Consolidation
2 A1.1 Stakeholder overview
3 A1.2 User needs and use cases
4 A1.3 User Requirements
5 D1 User requirements report
6 WP200 State of the Art
7 A2.1 State-of-the-art technologies
8 A2.2 Gap Analysis
9 D2 State of the art report
10 Progress Meeting 1
11 WP300 System Definition
12 A3.1 System and service specifications
13 A3.2 System and service architecture
14 A3.3 Validation plan
15 D3 System definition
16 Mid Term Review Meeting
17 WP400 Feasibility of the service concept
18 A4.1 Prototype design and development
19 A4.2 Prototype verification
20 A4.3 User feedback
21 D4 Digital media collection
22 WP500 Viability Analysis
23 A5.1 Market Analysis
24 A5.2 Cost/Benefit analysis
25 A5.3 Non-economic viability analysis
26 D5 Final Viability Assessment
27 Progress Meeting 2
28 WP600 Service implementation roadmap (d...
29 A6.1 Feasibility Status Assessment
30 A6.2 Implementation Roadmap
31 D6 Service Roadmap
32 Final Review Meeting
33 WP700 Management
34 A7.1 Management and reporting

Promotion activities

INTOGENER News
Intogener web site
Interview to Starlab and Endesa

at http://iap.esa.int

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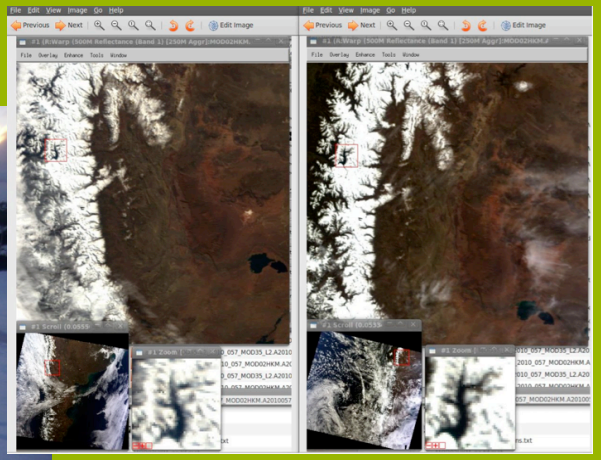
Some lessons learned so far…

- Expect the unexpected! remote mountain areas, different companies, great diversity and number of actors involved
- Document all work meticulously
- Establish clear agreements, including commercial aspects, between partners and users



Implementation of Envisat extension orbit in October 2010
04 June 2010

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Thank you for your attention

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