Earth Observation for Energy

International trends & developments

How to promote earth observation applications?

How to get funding?

Capacity building

0. Introduction

Mark Noort, consultant, project manager

HCP international:
consulting, marketing of earth observation

Coordinator GEONetCab:
project for promotion & capacity building of earth observation applications

Earth observation applications

- On the verge of reaching new user communities
- These new user communities need to be involved
- Weakest link / last mile aspects are important
- Marketing needed: promotion & capacity building

Life cycle of products & services

Initialization

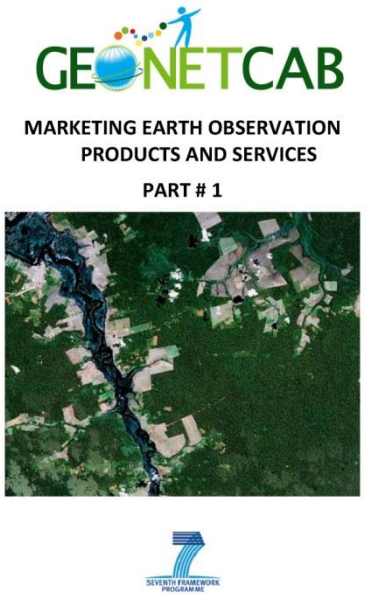
System analysis & design

Rapid prototyping

System development

Implementation

Post-implementation



Assessment of business & funding opportunities

- Categories of environmental products & services
- Life cycle phase of product or service
- Regional context, level of technological & economic development
- Optimum marketing mix

1. International trends & developments in energy

Trends

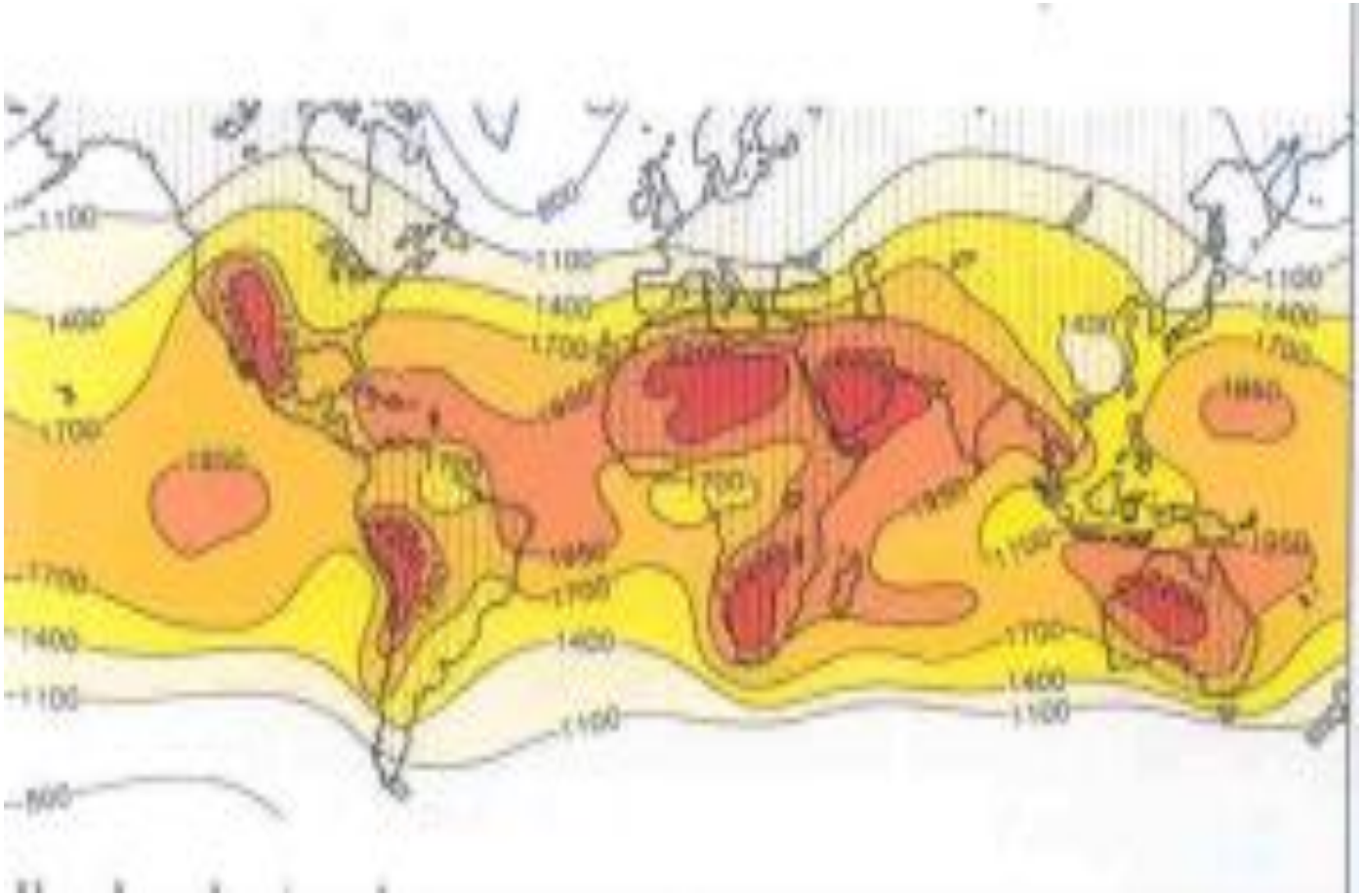
- Increased attention for renewable energy
- Search for new energy sources (including biofuel)
- Increased attention for energy saving
- Anticipation on the possible effects of climate change

Renewable energy sources:

- Solar energy
- Wind energy (onshore and land-based)
- Wind energy (offshore)
- Bioenergy
- Hydropower
- Geothermal energy

Solar energy

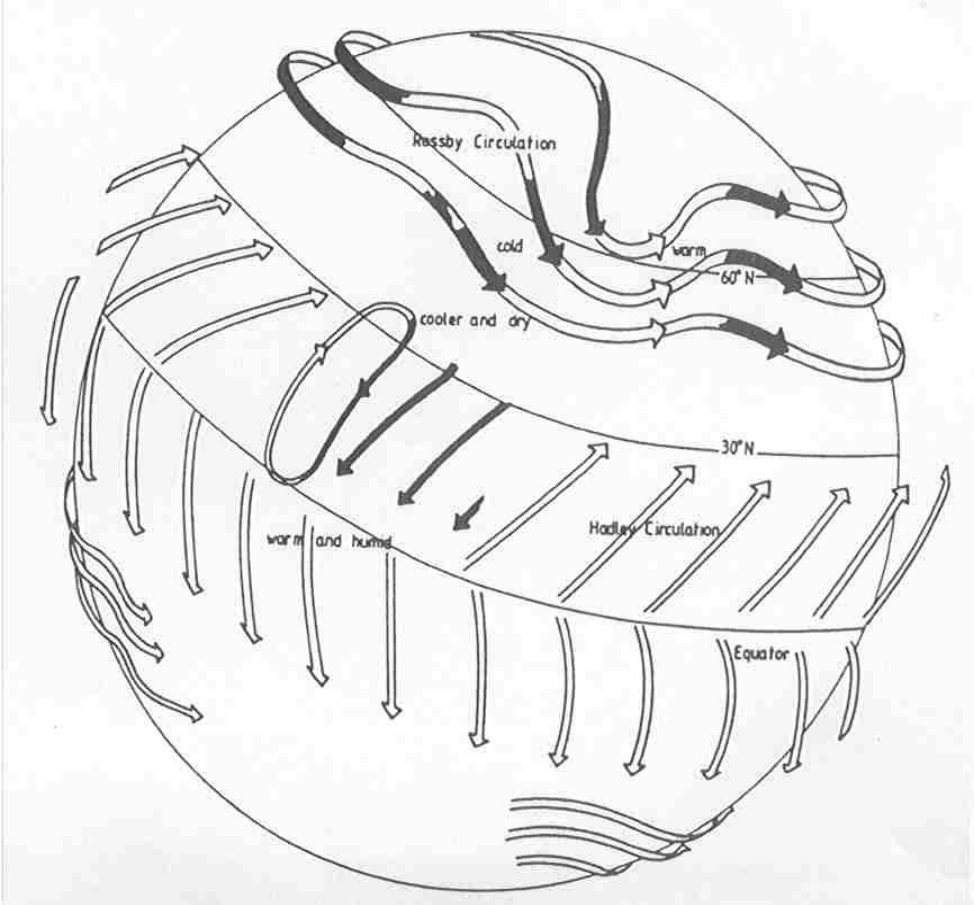
Yearly solar irradiation against a horizontal surface (kWh/m2)



New renewable energy, Norwegian developments, Kan Energy AS (1998)

Wind energy

Global circulation of wind over the Earth



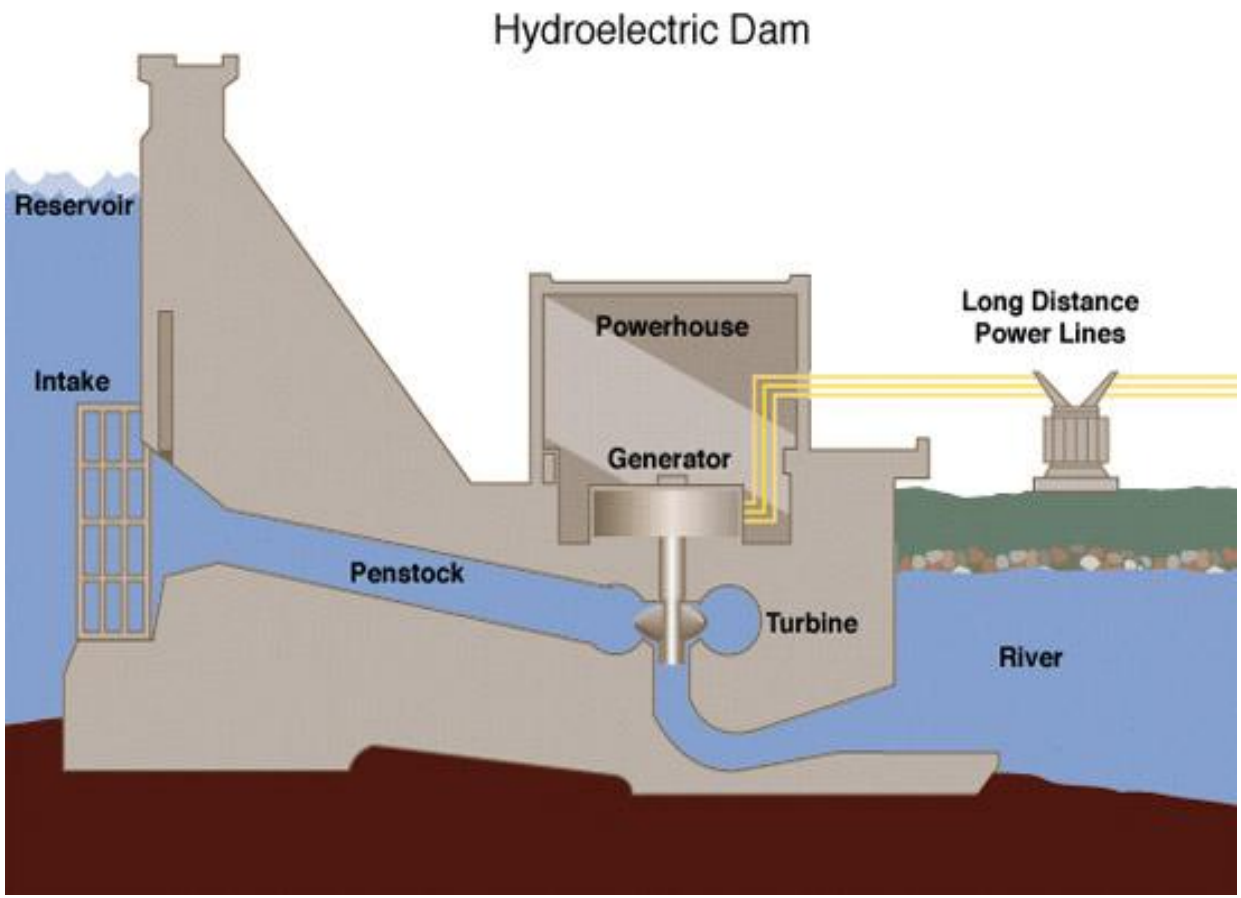
New renewable energy resources, WEC (1994)

Bioenergy

(See also crop modelling toolkit)

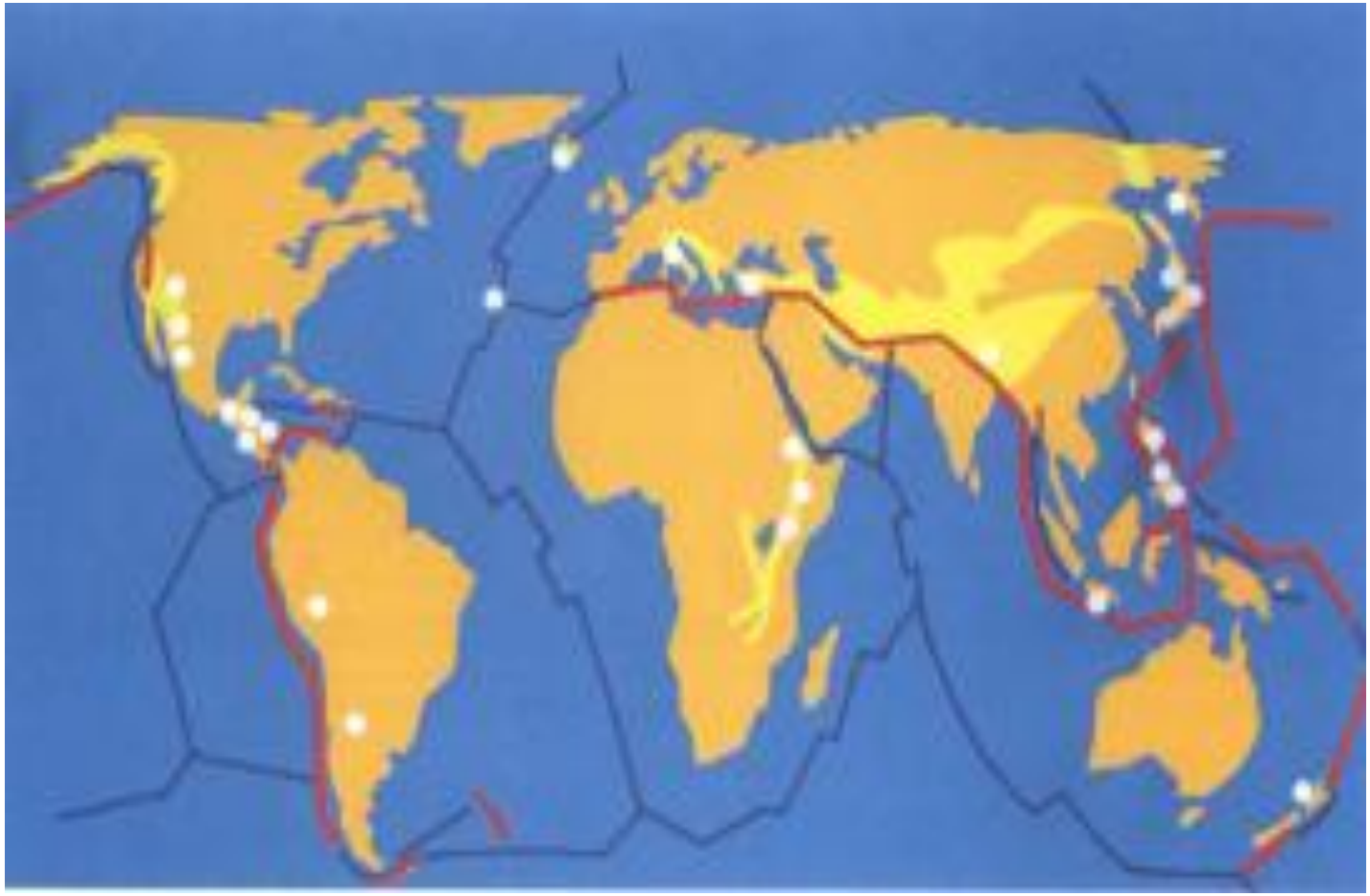
Hydropower

(See also water management toolkit)



Geothermal energy

World map of lithospheric boundary plates



White dots: areas where geothermal projects are in operation
Nemzer, M. , Geothermal education office (2000)
http://geothermal.marin.org

Renewable energy handbooks

(See also 4. Capacity building)

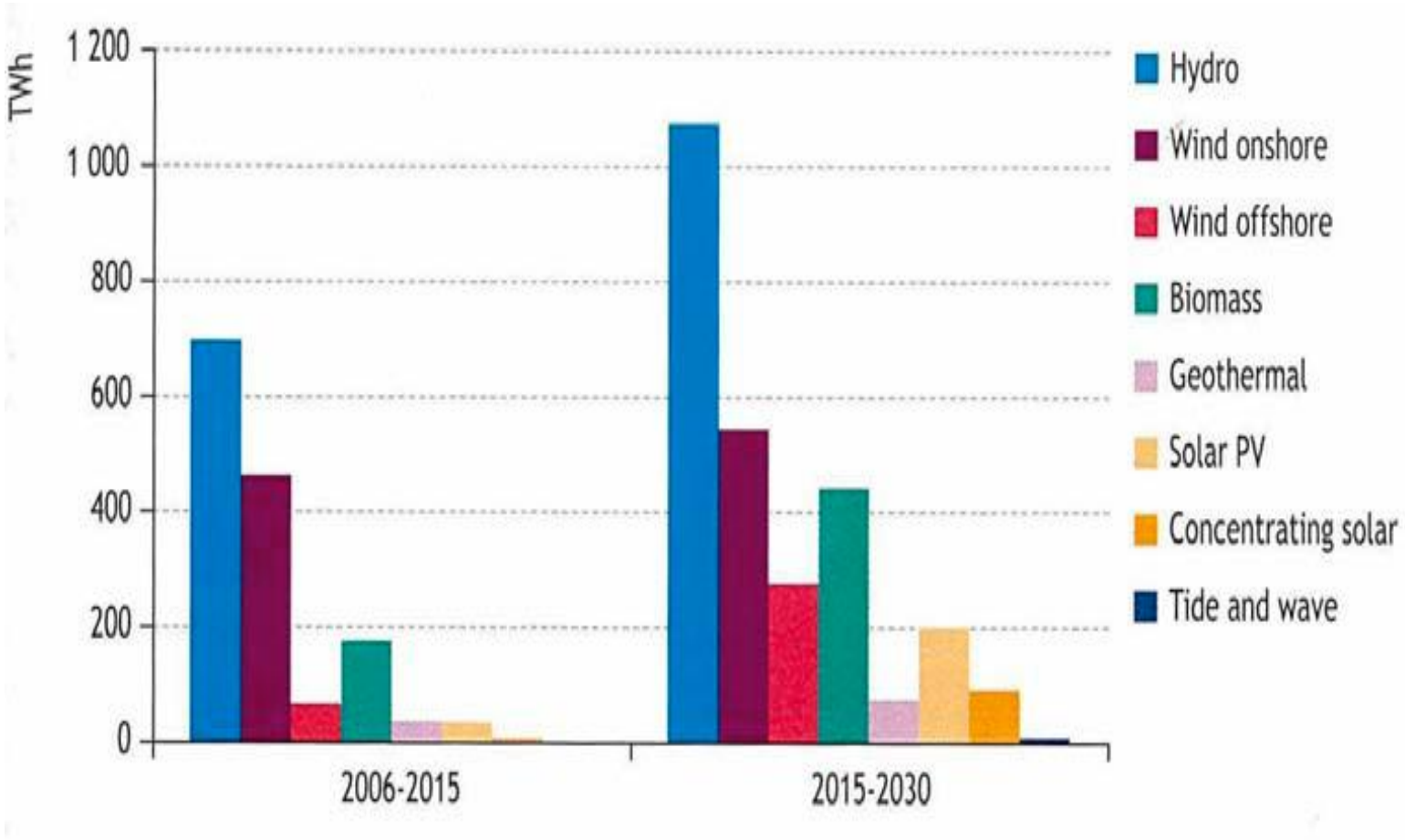
Renewable energy projects handbook (WEC)
Overview of renewable energy options, potential and main features of each type of renewable energy + political and financial considerations, project checklist and a description of the environmental credits acquisition process

Global Energy Information System www.worldenergy.org
Case studies on renewable energy from different countries

Promise of renewables (CSIS)
Commentary on trends, developments, problems: renewable is more expensive than fossil, but investment is growing

Renewable energy outlook

Increase in world electricity generation from renewable energy



World energy outlook 2008 reference scenario

References solar energy:

Solar energy perspectives (IEA)
Comprehensive overview: if you want use solar energy, start here!

Renewable energy essentials: Solar heating and cooling (IEA) *Short overview of markets and potential*

Renewable energy essentials: Concentrating solar thermal power (IEA) *Short overview of markets and potential*

Technology roadmap: Solar photovoltaic energy (IEA)
Plan for future action, based on current and anticipated trends

Technology roadmap: Solar heating & cooling (IEA)
Plan for future action, based on current and anticipated trends

References wind energy:

Technology roadmap: Wind energy (IEA)
Plan for future action, based on current and anticipated trends and stressing the importance of standards for resource assessment, sharing of wind resource data and improving wind forecasting accuracy

Renewable energy essentials: Wind (IEA)
Short overview of markets and potential

References bioenergy:

Biofuels: policies, standards and technologies (WEC)
Overview of the current state of affairs, including sustainability criteria

Strong growth in biofuel market

Currently, two countries: Brazil and USA account for nearly 80% of global biofuels production. Both countries produce mainly bioethanol: USA from maize and Brazil from sugar cane.

Sustainable biofuel production practices would not hamper food and fibre production nor cause water or environmental problems but would actually enhance soil fertility.

Good practice guidelines: Bioenergy project development & biomass supply (IEA)
Guide towards a sustainable and profitable approach

References hydropower & geothermal:

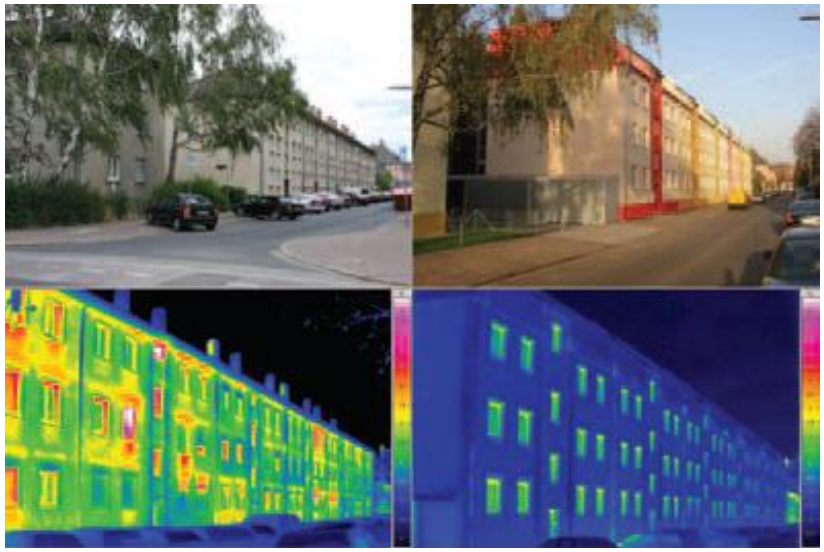
Renewable energy essentials: Hydropower (IEA)
Short overview of markets and potentials

Renewable energy essentials: Geothermal (IEA)
Short overview of markets and potentials

References energy efficiency:

Mind the gap: Energy efficiency (IEA)
Comprehensive discussion of barriers and solutions with respect to achieving energy efficiency, based on agency theory

Technology roadmap: Energy-efficient buildings (IEA)
Graphic visualization of roadmap and targets



Frankfurt refurbishment using passive housing technology

Top photos: the building before and after refurbishment

Bottom images:
infrared visualization of the heat losses before and after the refurbishment

Source: Passive House Institute Darmstadt

Not renewable, but interesting:

Shale gas, what's new (WEC)
Overview of the current state of affairs

Shale gas 2010 (WEC)
Idem

Competition for strategic materials (CSIS)
Commentary on availability of rare earths, also needed for production of renewable energy!

Climate change:

Climate impact on energy systems (World Bank)

Adaptation is essential: changing trends, increasing variability, greater extremes and large inter-annual variations in climate parameters are expected.

Better risk management and more resilient infrastructure are required. Increasing the capacity to use information is required, especially in developing countries -> see climate toolkit.

Observation and monitoring of hydro-meteorological and climate parameters for select energy uses are important, virtually all involve earth observation -> see climate toolkit.

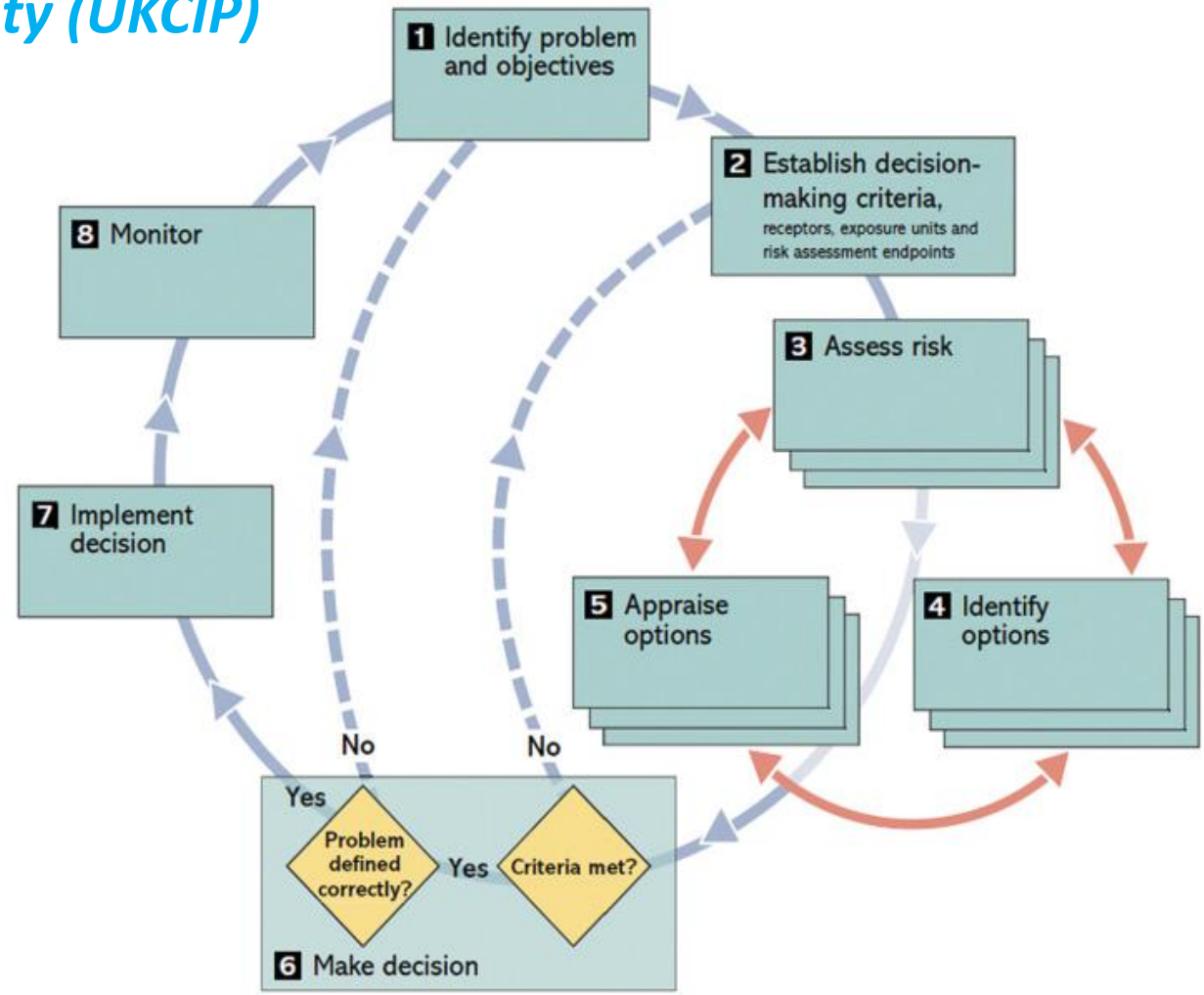
Energy/water saving, demand-side management, energy storage, smart grids, decentralized energy structures, increased vehicle efficiency are important.

Observation networks in developing countries need to be upgraded to minimum WMO standard.

Case studies from Albania and Mexico

Decision making

Framework for climate change adaptation decision making under uncertainty (UKCIP)



Willows and Connell. Climate adaptation: Risk, uncertainty and decision-making. UKCIP Technical Report (2003)

2. Steps to promote earth observation for energy

State-of-the-art

Earth observation is new technology.

Learn technical skills, but when back in professional practice, it has to be put to good use.

That involves ‘selling’ it.

How to do that?

To whom? Could be your own boss, local authorities, communities, etc.

Categories of products and services

- Resource assessment for (renewable) energy
- Energy resources exploration support
- Pipeline monitoring
- Optimization of biofuel production *(see crop modelling toolkit)*

Niche markets:

- Sustainable building design
- Prediction of damaging geomagnetically induced currents (GICs)
- Effect of climate change on energy requirements

Earth observation comparative advantages

- Increased accuracy
- Cost reduction / increase of revenue
- Better planning
- General innovation

Critical Earth observations priorities: Energy societal benefit area (GEO)

- **Tier 1 High Priority Parameters:**
  Water run-off, wind speed, land cover, Normalized Difference Vegetation Index (NDVI), Net Primary Productivity (NPP), Global Horizontal Irradiation (GHI), Direct Normal Irradiation (DNI)
- **Tier 2 Medium Priority Parameters:**
  Elevation /topography, air temperature, surface temperature, relative humidity, and cloud cover

See also: GEO Energy Community of Practice www.geoss-ecp.org

Earth observation parameters for Solar Energy

Parameter Type	Priority Parameters
Characterization of Solar Resource	**Direct normal irradiation (DNI)** **Global horizontal irradiation (GHI)** Diffuse irradiation Inclined plane radiation Cloud cover (cloud index) Circumsolar ratio
Meteorological Parameters	Wind speed Wind direction Ambient air temperature
Atmospheric Composition	Aerosol optical depth (AOD) Water vapor content Atmospheric ozone content

boldface type: key parameters for this subarea. *Some derived parameters listed here may rely upon the measured parameters also listed in this table*.

Earth observation parameters for Wind Energy

Parameter Type	Priority Parameters
Meteorological Parameters	**Wind speed** Wind direction Vertical wind profile Turbulence Wind shear Relative humidity Ambient air temperature Atmospheric pressure
Land Parameters	Topography/elevation Land cover Surface roughness
Offshore Environment Information	Wave height Current speed Tides Bathymetry Sea surface temperature

boldface type: key parameters for this subarea. *Some derived parameters listed here may rely upon the measured parameters also listed in this table*.

Earth observation parameters for Bioenergy

Parameter Type	Priority Parameters
Land information	**Land cover (including ecosystem type and identification of specific crops)** Elevation/topography Texture
Meteorological Parameters	**Normalized Difference Vegetation Index (NDVI)** **Net Primary Productivity (NPP)** Evapotranspiration Soil Moisture Soil carbon content Groundwater storage
Land Parameters	Precipitation Air temperature Relative humidity Surface temperature
Characterization of Solar Resource	Direct normal irradiation (DNI) Global horizontal irradiation (GHI) Spectral distribution Cloud cover (cloud index)

boldface type: key parameters for this subarea. *Some derived parameters listed here may rely upon the measured parameters also listed in this table*.

Earth observation parameters for Hydropower

Parameter Type	Priority Parameters
Water Parameters	**Water run-off** Stream/river flow Lake/reservoir height Snow water equivalent Groundwater storage Near-surface water and sea-surface temperature (for large lakes)
Meteorological Parameters	Precipitation Air temperature Wind speed Relative humidity Pressure Cloud cover
Land Parameters	Topography/elevation Land cover Snow cover Synthetic aperture radar images

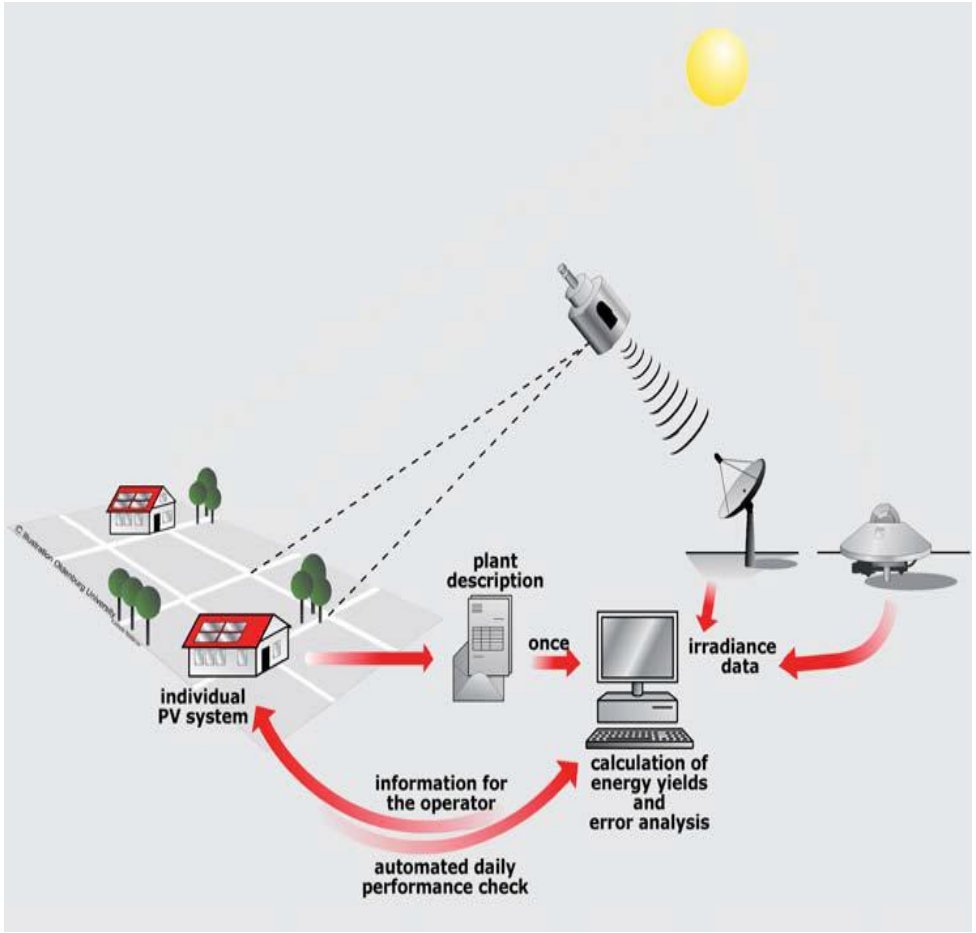
boldface type: key parameters for this subarea. *Some derived parameters listed here may rely upon the measured parameters also listed in this table*.

Earth observation parameters for Geothermal

Parameter Type	Priority Parameters
Characterization of Geothermal Resource	**Temperature of geothermal fluid (at depth)** Fluid pressure **Water Chemistry** Rock Permeability
Land Information	Elevation/topography and surface deformation (change in elevation) Land cover Land surface temperature

boldface type: key parameters for this subarea. *Some derived parameters listed here may rely upon the measured parameters also listed in this table*.

Decision support



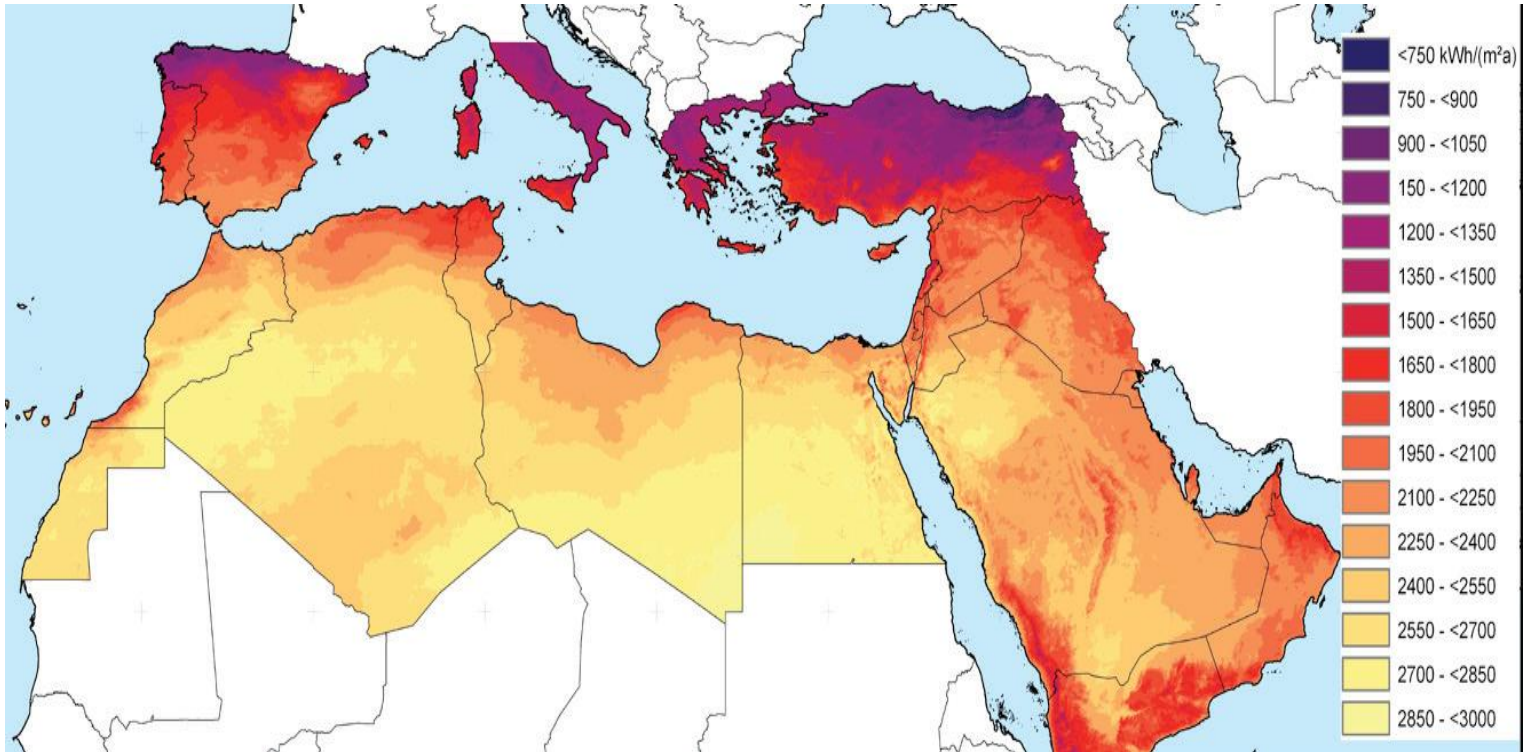
Uses and limitations of observations, data, forecasts, and other projections in decision support for selected sectors and regions (CCSP)

With chapter of DSS for assessing hybrid renewable energy systems: description of HOMER (hybrid optimization model for electric renewables). HOMER makes use of earth observation data and a geospatial toolkit.

Resource assessment for (renewable) energy

Highlighting Earth's solar resources from space (GMES) (1)

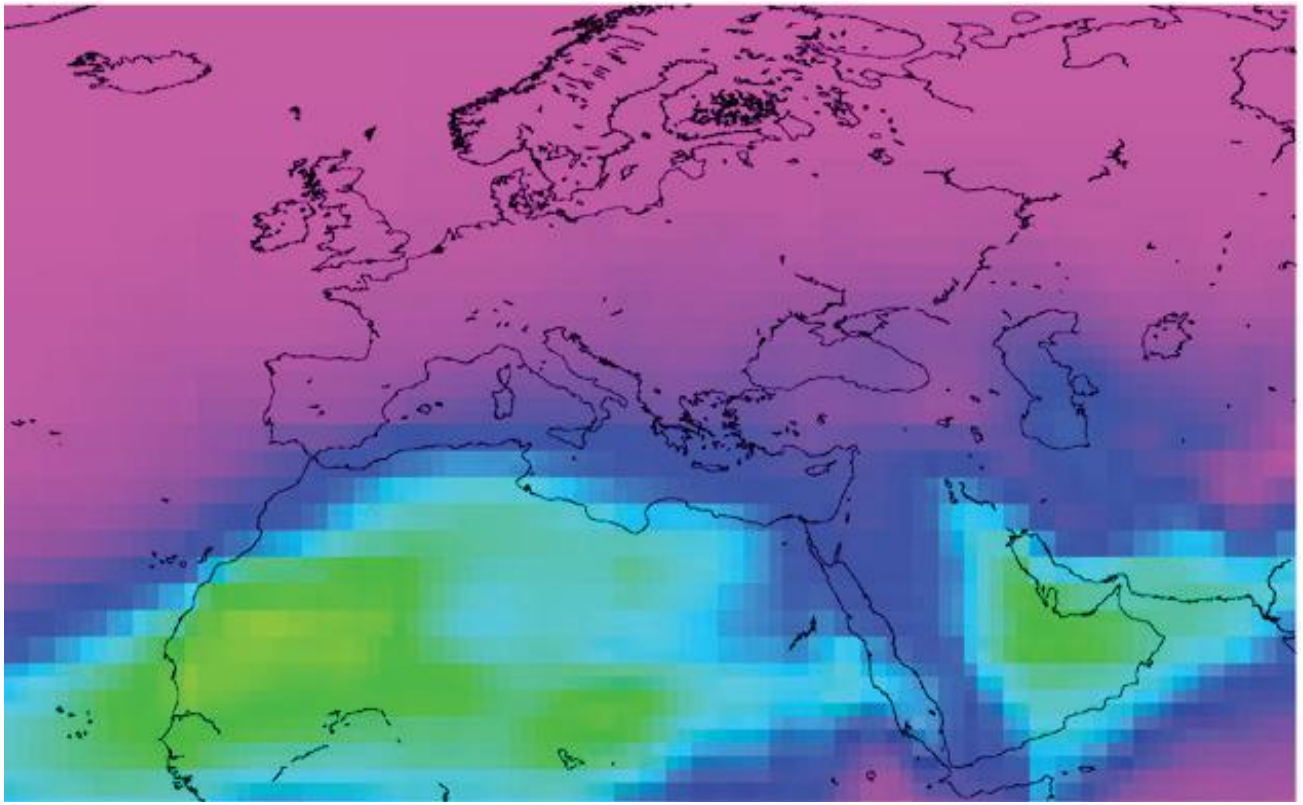
Solar resource mapping and open access to GMES Sentinel data



Energy resource map: Annual solar irradiance in the Mediterranean region (kWh/m²). Source: DLR

Highlighting Earth's solar resources from space (GMES) (2)

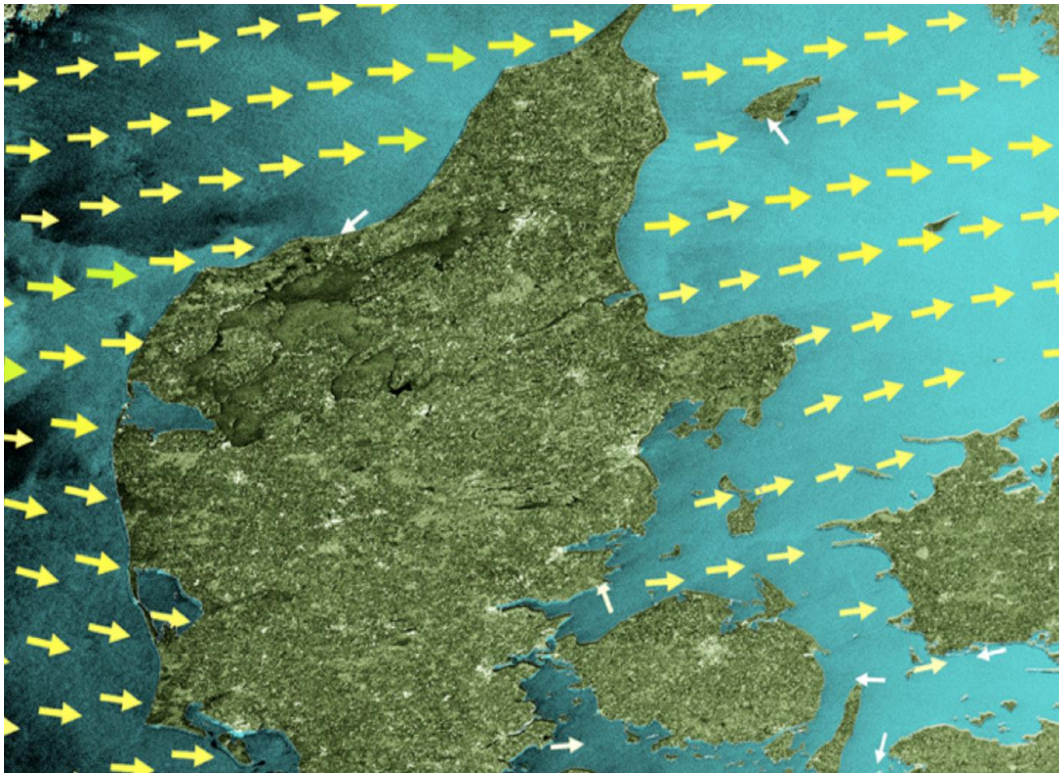
Solar resource mapping and open access to GMES Sentinel data



Energy reduction map: Number of days with solar radiation extinction above 30% (180 – 280 days/year for green areas). Source: DLR

Space supports Europe's renewable energy future(GMES)

Used: radar altimeters, scatterometers & image radar sensors



This coloured Envisat ASAR radar image, which is normally black and white, shows the wind fields over the North Sea around Denmark and northern Germany in September 2009.

Speed values range from 0–32 km per second.

Wind speeds and directions are indicated by the size and colour of the arrows.

Source: EEA & ESA

References ENVISOLAR & MESoR:

ENVISOLAR space-based environmental information for solar energy industries
Brochure with overview of services and examples, including services for investment decisions, plant management, utilities, time-series services for science and consulting and a description of the PV-calculator tool

MESoR (management and exploitation of solar energy knowledge)
www.mesor.net continued at http://www.webservice-energy.org/

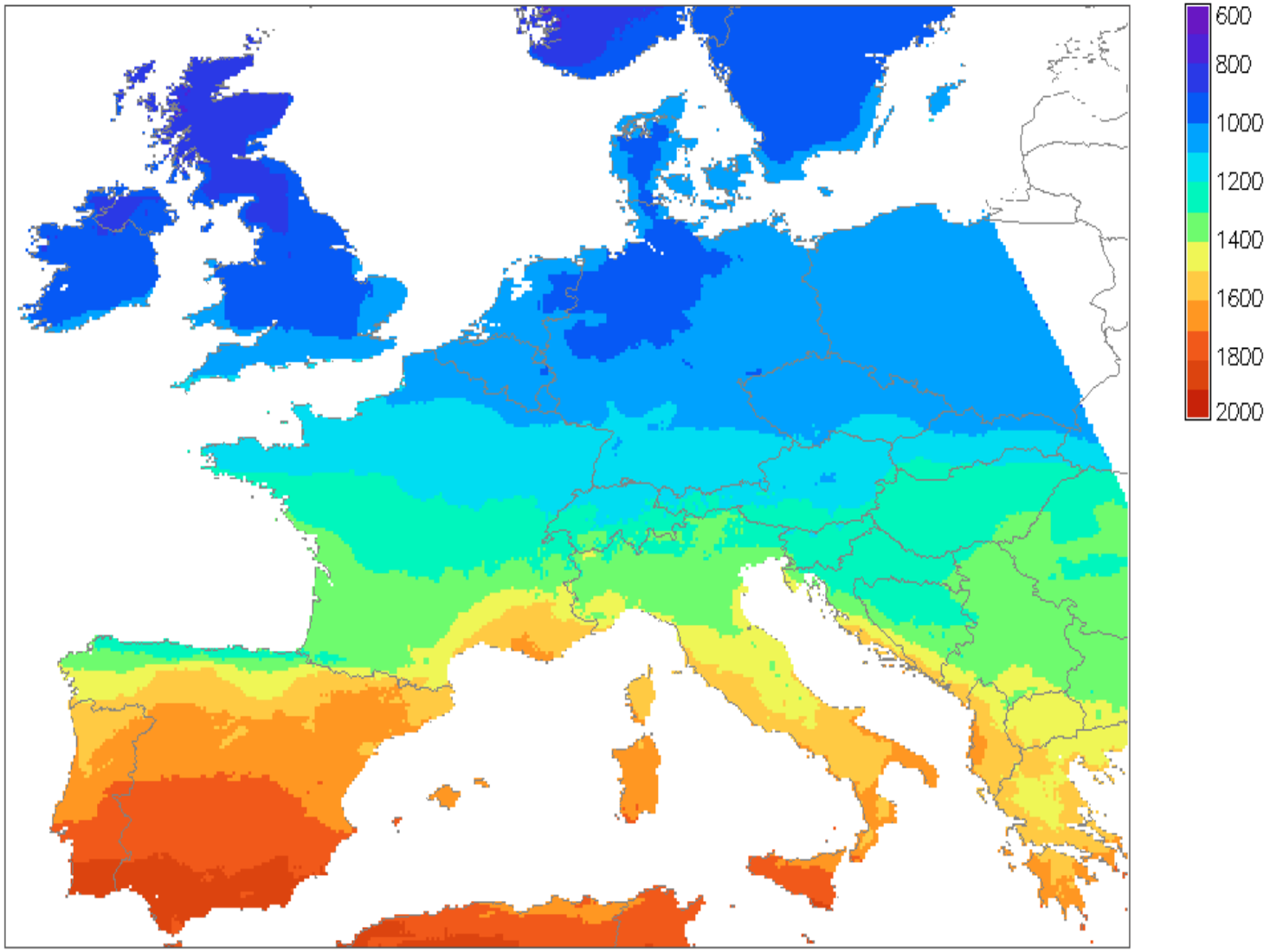
Description of solar resource products, summary of benchmarking results and examples of use (MESoR)
Overview of and comparison (benchmarking) of different methods for measuring irradiation + 20 use cases

Needs for new solar radiation services to faster deploy the market for solar energy applications and optimize grid integration (MESoR)
Recommendations for improvements in observations and forecasts

MESOR

Yearly sum of global horizontal irradiation: average of all databases [kWh/m2]

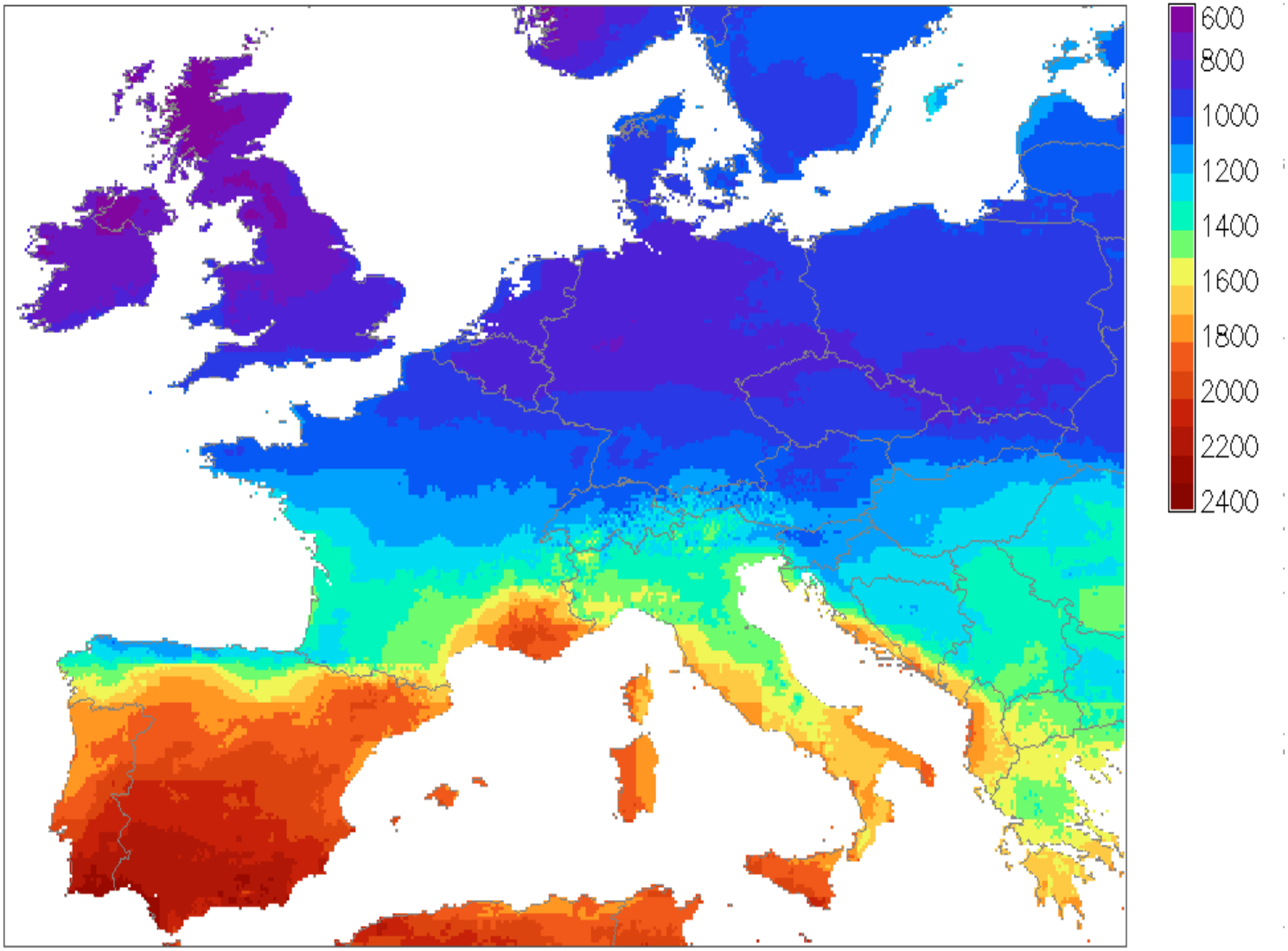
(databases: EnMetSol, ESRA, HelioClim-2, Meteonorm 6, NASA SSE 6, PVGIS, Satel-Light, SOLEMI)



MESOR

Yearly sum of direct normal irradiation: average of all databases [kWh/m2]

(databases: Meteonorm 6, NASA SSE 6, PVGIS, Satel-Light and SOLEMI)



References RETScreen:

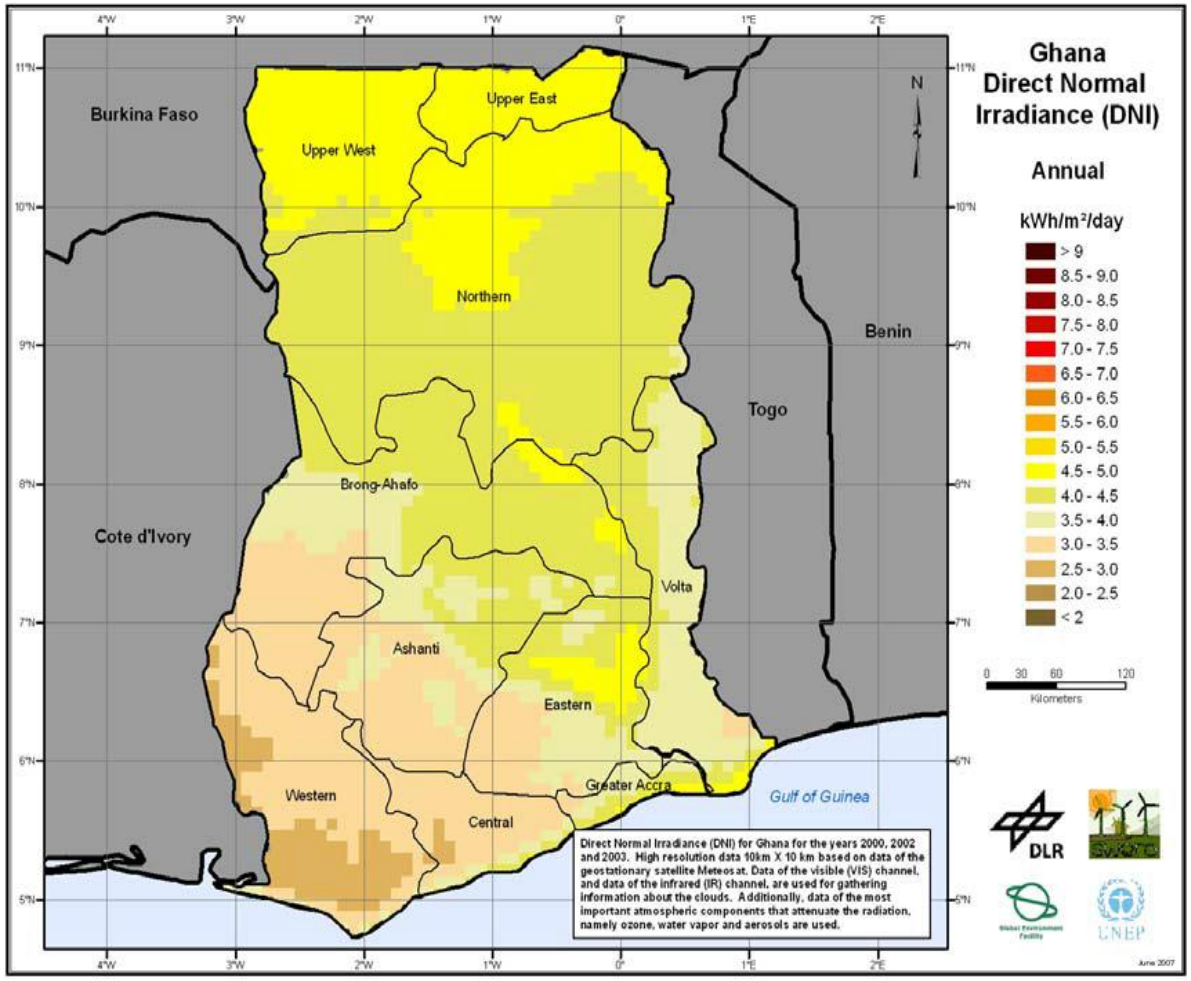
RETScreen international (Natural Resources Canada)
Brochure on RETScreen initiative www.retscreen.net

Clean energy projects, RETScreen engineering & cases textbook
Description of clean energy decision-making software; uses worldwide database of NASA satellite-derived meteorological data (NASA surface meteorology and solar energy dataset (SSE)) from a ten-year period (1983 – 1993)

Related information:

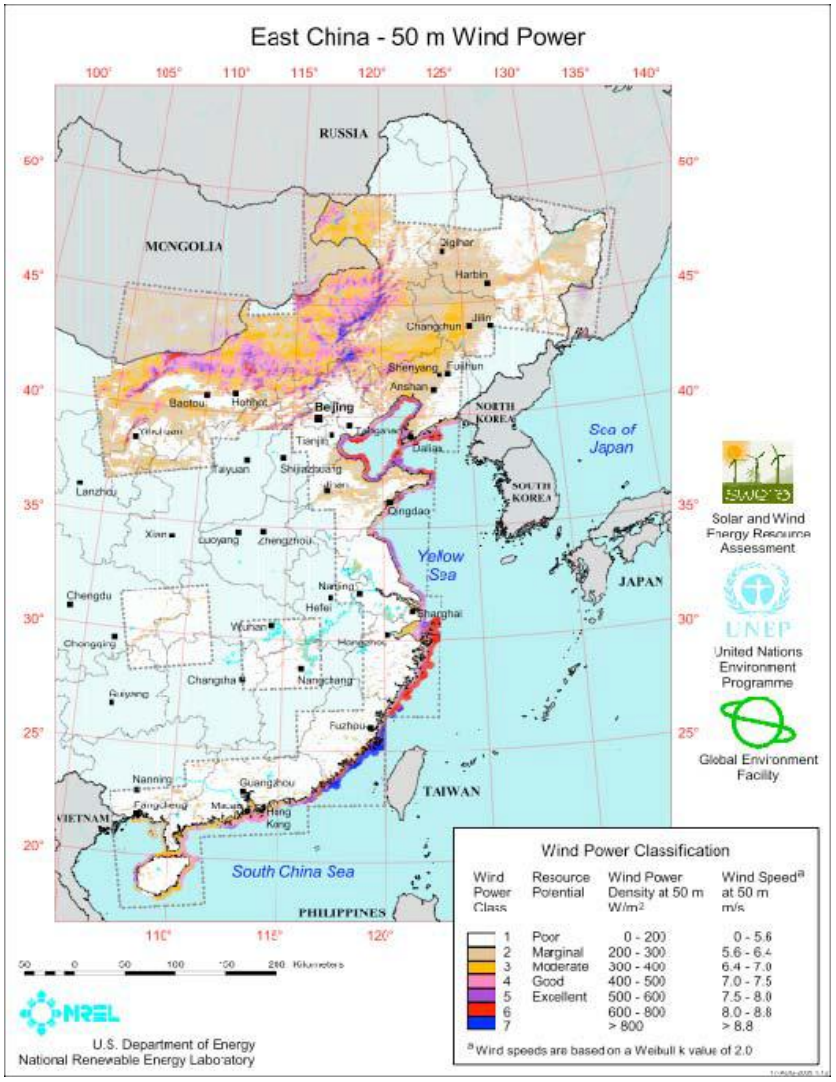
Solar energy data for developing countries (GEO-ECP)
Short description of, and links to, SSE, Helioclim and SODA

Solar and Wind Energy Resource Assessment (SWERA) (1)



User manual

Solar and Wind Energy Resource Assessment (SWERA) (2)



User manual

References SWERA (1):

Results of solar resource assessments in the UNEP/SWERA project
Article with summary of the results in the 13 SWERA countries

Global atlas for solar and wind energy end-user needs assessment
Presentation of the end-user assessment for SWERA products (policy-makers, developers, NGOs/universities, global modelling community). SWERA is used as first data source (to identify high-potential areas), but is not enough for decision-making. More capacity building needed.

Solar and wind energy resource assessment (GEF)
Success story with summary of SWERA achievements

References SWERA (2):

Enhancing information for renewable energy technology deployment in Brazil, China, and South Africa
Description of resource assessment for solar and wind energy in the three countries + comparison between the countries

Terminal evaluation of UNEP GEF project solar and wind
Evaluation report of the SWERA project with lessons learned and recommendations (establishment of a knowledge network)

User manual for SWERA: designing renewable resource assessment projects and using assessment products
User manual for SWERA and related products + guidance on where to find information

Other references wind energy:

Satellite based services for the wind industry
Article describing the use of EO data for wind farms (wind measurements over the ocean, wave statistics, tidal heights and currents, terrain roughness, orography)

Wind forecasting presentation (US)
Description of forecasting systems, models, time horizons and forecast performance + recommendations to improve wind forecasting

Assessment of wind resources (Denmark)
Presentation on the use of earth observation for WAsP (wind atlas analysis and application programme)

Other references: bird protection

Challenges and solutions of remote sensing at offshore wind energy developments
How to improve bird protection in relation to wind energy projects; application of radar and GIS for off-shore and on-shore wind energy projects

Fuzzy modelling to identify areas of high conservation value for raptors: effectiveness of the network of protected areas in Andalucia (Spain)
Master thesis on earth observation and GIS for bird protection and wind energy development schemes

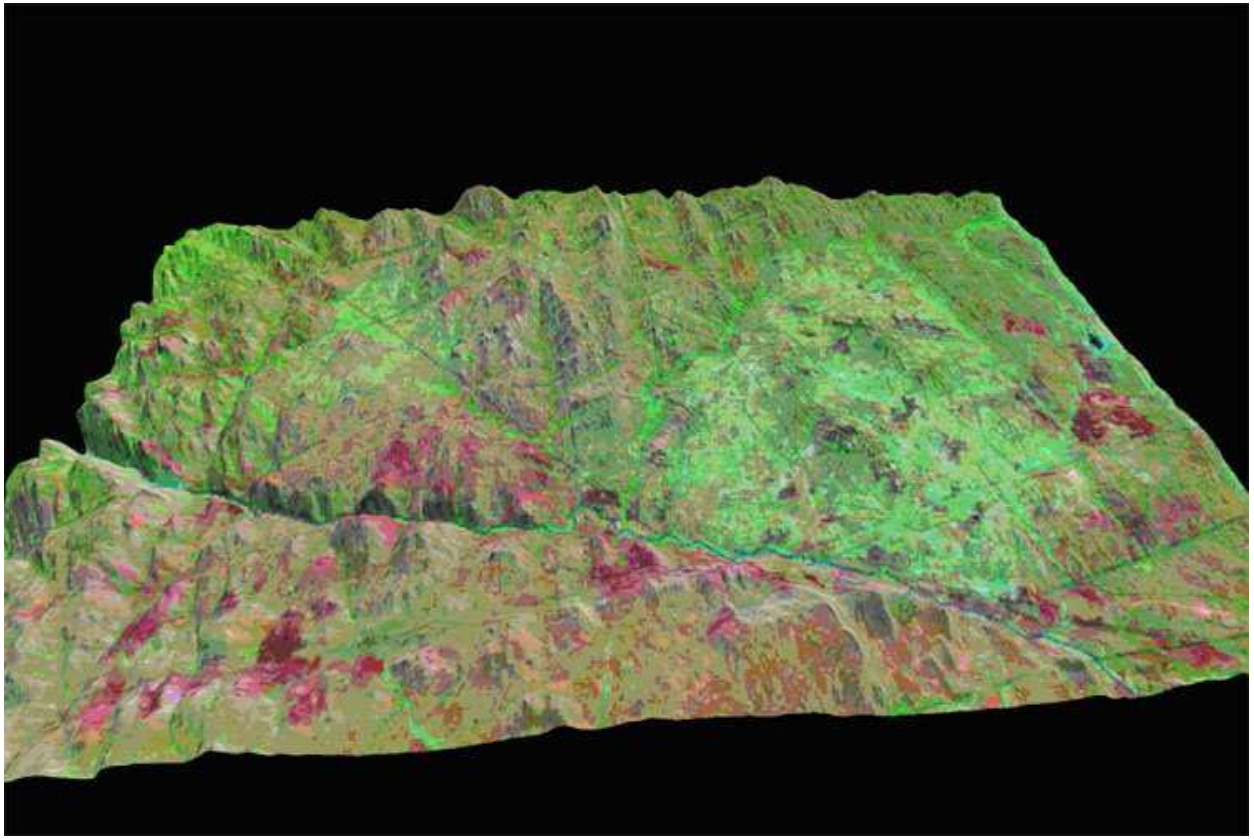
See also: environmental management toolkit

Energy resources exploration support

African-European georesources observation system (AEGOS)

AEGOS
AFRICAN-EUROPEAN GEORESOURCES OBSERVATION SYSTEM

Archive of public Africa-related georesources data



Landsat ETM+ satellite image of the Catanda carbonatite massif (Angola) superimposed on DEM

AEGOS references:

AEGOS Review of spin-off projects based on AEGOS, preparation of a road map for AEGOS test beds
Description of 8 geological mapping initiatives in Africa

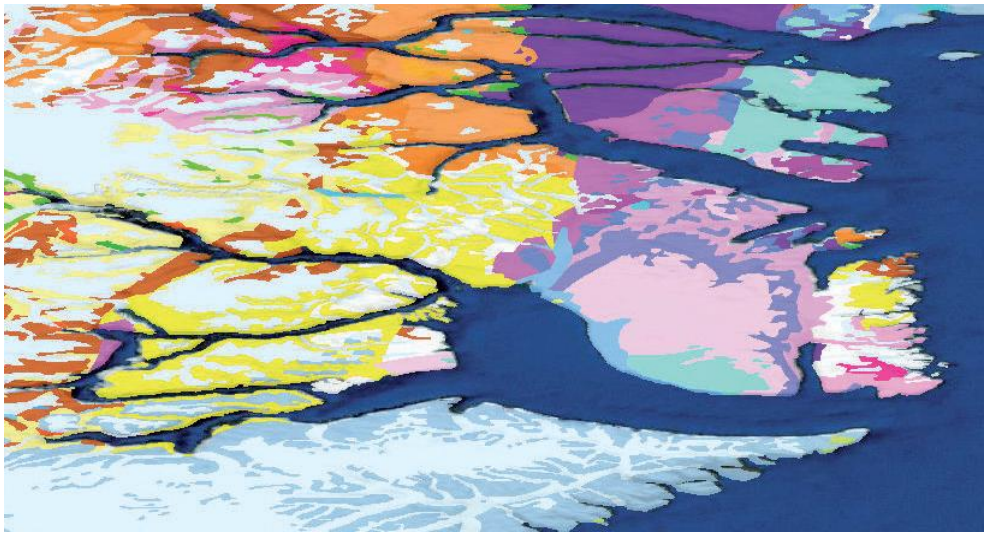
AEGOS: The spatial data infrastructure for georesources in Africa *Overview presentation of the AEGOS initiative*

Related article:

Multi- and hyperspectral geologic remote sensing: a review (ITC)
Description of the state-of-the-art of remote sensing for geology, stressing the importance of validation, bridging the gap between earth observation and geology, a multidisciplinary approach and data continuity

One Geology:

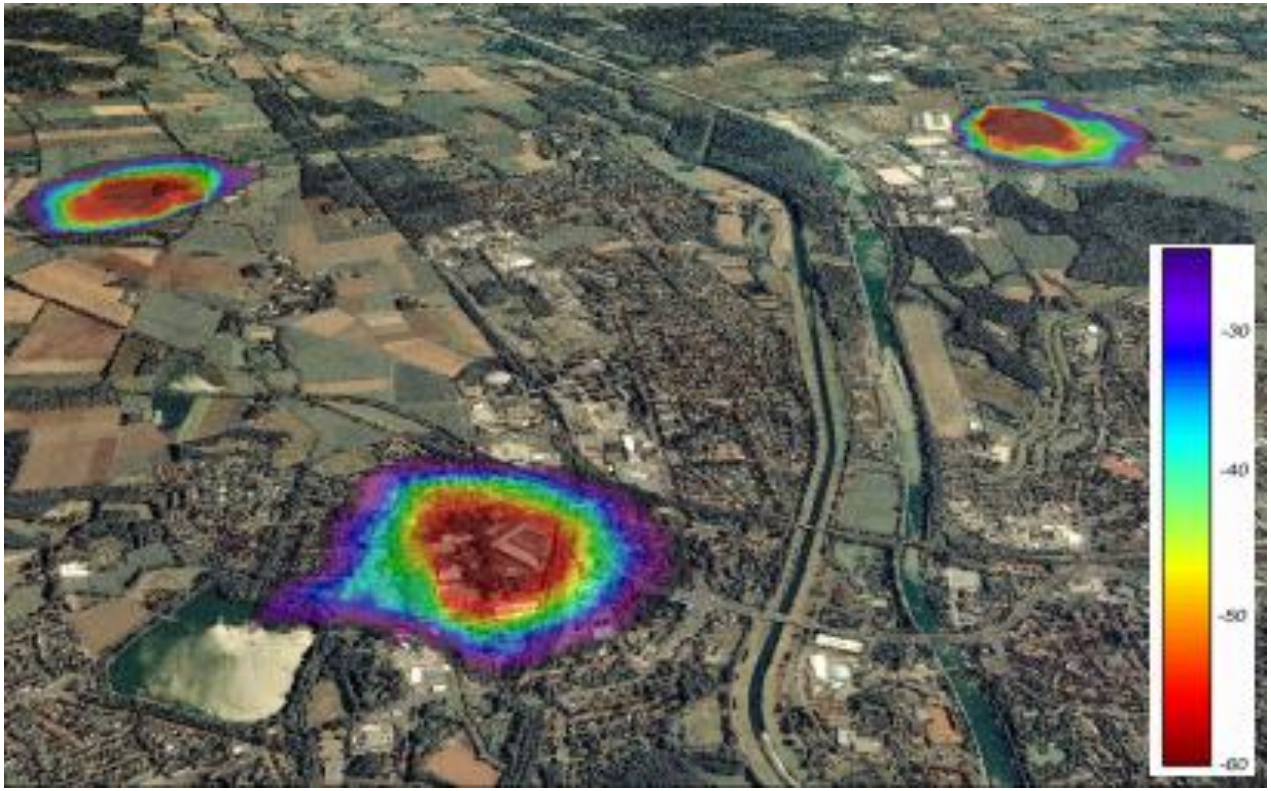
Geological maps for more than 70 countries
Including information on geothermal showcases in Australia and France, and the digital energy map of the UK
www.onegeology.org



Initiatives,
such as AEGOS
and One Geology,
also support energy
resources assessment!

Pipeline monitoring

PIPEMON project



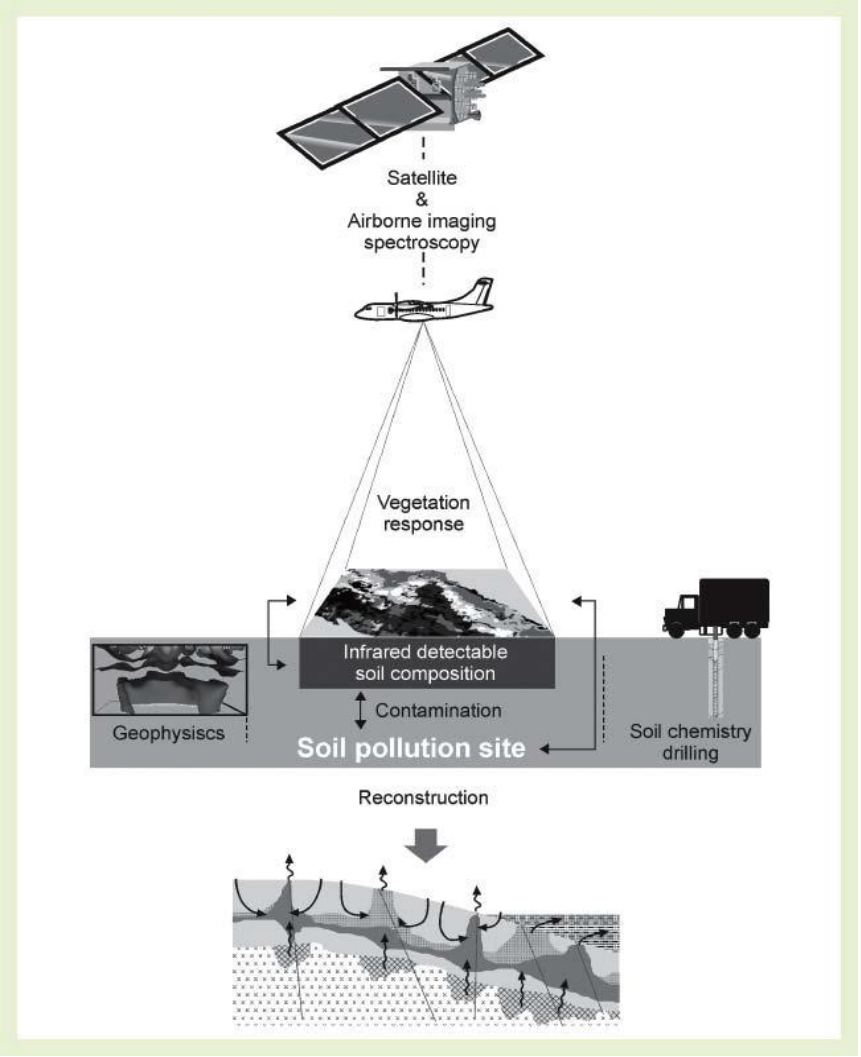
ground motion monitoring service
&
route planning service

Application of ground movement and automated route planning technologies for pipeline planning and management – the PIPEMON project *Description of detection of pipeline-related ground and structure motion (with SAR) and planning of routes for pipelines (using DEMs and interferometry)*

Other references:

Oil and gas spill and pipeline condition assessment using remote sensing (EPA)
Overview of methodologies for pipeline monitoring in the US

Environmental Impacts of pipelines (ITC)
Article describing the use of remote sensing for detection of seepage from pipelines



Other topic: geomagnetically induced currents

Power and pipelines (ground systems)

Article on the effects of space weather (geomagnetically induced currents) on power lines and pipelines and what remote sensing can do about it

Possible business opportunities

- Further development and refinement of models and forecasts;
- Application of existing models and software tools to improve knowledge base and forecasting ability (particularly in developing countries);
- Use earth observation to compensate for lack of in-situ data (particularly in developing countries);
- Market opportunities both B2G and B2B.

Marketing of earth observation

Marketing of earth observation is difficult.

New technology, few big companies, lots of small ones.

Lots of reports describing the bottlenecks, like reliability, data access, data continuity, etc.

Means that relatively a lot of effort is needed to promote EO.

Points to keep in mind:

- Look for opportunities, where can you have most success in a short time: quick-wins.
- Target the right audience to start with: who would be interested and listen to you?
- Identify the problem that they are trying to solve: is it the same as yours?
- Learn to speak the same language. Example ‘lithospheric’: this is a term most politicians do not understand and do not care about. Use terms related to profits and losses.
- Look for examples from elsewhere (success stories): solutions that work and are affordable.

Be patient:
introduction of new technology
and / or applications takes time

3. How to get funding for your activities

Approach

- Share information on your subject (a thing you are doing) and think that is interesting for your contact, then look for the link. Could this solve a problem for your partner? Are adjustments necessary? Need other parties be involved? Take it from there.
- LEADS, LEADS, LEADS

GEONETCAB

How?

- Establish your network.
- Look for opportunities.
- Write a good proposal.
- Promise much, but not too much.

Proposal outline

(more detailed version in separate document, see also www.geonetcab.eu)

1. Introduction / relevance
2. Objective(s)
3. Activities
4. Output
5. Management & evaluation
6. Risk assessment
7. Time schedule
8. Budget

Annexes

Other references

- Civicus: writing a funding proposal
- Michigan State University: guide for writing a funding proposal
- ESRI: writing a competitive GRANT application
- REC: project proposal writing

Again:

- *SHARED PROBLEM*
- *SHARED LANGUAGE*
- *SHARED SOLUTION*

If all else fails, try to link with a more popular (and easy to understand) topic.

4. Capacity Building

General

Marketing is promotion + capacity building.

Especially for the introduction of new technologies capacity building is important at all levels.

Capacity building is the instrument to increase self-sufficiency and make solutions work.

Think of:

- Different instruments for different levels: workshops for decision makers and awareness raising, detailed technical training for professionals.
- Provide follow-up. Getting funding for good capacity building is difficult: everybody agrees that it is important, but nobody has time.
- Training is usually part of funding of big projects that are managed by big companies or ministries, as a consequence capacity building is forgotten (in the end).
- Aim at small budgets that are available without having to tender.

Examples & references

MESoR training seminar on solar radiation services
Presentations from the MESoR training seminar + use cases

See also MESoR user handbook & RETScreen engineering textbook

AEGOS Inventory of available curricula of training centers and practices
Overview of IT, data management, GIS, RS and web applications courses (Europe, Africa, distance)and thermal infrared

AEGOS Concept note about the needs in capacity building and training
Overview of competencies required to work with the AEGOS data infrastructure and the existing gaps in Africa

Examples & references

Wind energy handbook (Wiley)
Everything you need to know…

Wind resource assessment handbook (US)
Do-it-yourself handbook for wind energy, including required parameters (from the pre-EO age)

Capacity building output of the EnerGEO project
www.energeo-project.eu

GEONetCab capacity building web www.geonetcab.eu
Compilation of tutorials, references, open-source software, etc.

GEO Portal: www.earthobservations.org

More references

A Rough Google Earth Guide

MEASURE Evaluation Global Positioning System Toolkit (USAID)

Handbook of Research on Developments and Trends in Wireless Sensor Networks: From Principle to Practice

Further details:

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m.noort@hcpinternational.com

www.geonetcab.eu