Earth Observation for Crop Modelling

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

MARKETING EARTH OBSERVATION
PRODUCTS AND SERVICES

PART # 1

Assessment of business & funding opportunities

- Categories of environmental management products & services

- Life cycle phase of product or service

- Regional context, level of technological & economic development

- Optimum marketing mix

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1. *International trends & developments in crop modelling*

Climate change

Climate change becomes more and more important,
local adaptation focuses on disaster management and food
security

References:

Western Australia: WA Agriculture Climate Science

Example of 'how to be prepared':

Aims at **better prediction** of: yields (yield prophet), changing land use on unproductive soils, preparedness for drought (off-farm employment & new farming systems).

This is done by: soil characterization, **biomass estimation & crop yield from space**, cropping decisions based on Yield Prophet, economic resilience index, carbon sequestration on native vegetation (poor soils).

Real-time & local **weather information** + seasonal forecasting + **historical analysis**: **farmers like the short-term forecasts** (also of extreme events), but critical of seasonal forecasts. Early part of season is critical for decision on sowing, fertilizer rate, weed & pest control.

Climate change perception: what is influencing attitudes (credibility of science versus local knowledge, how does information translate into action)?

Climate Change and Food Security:

A framework document

Description of processes and possible adaptive measures
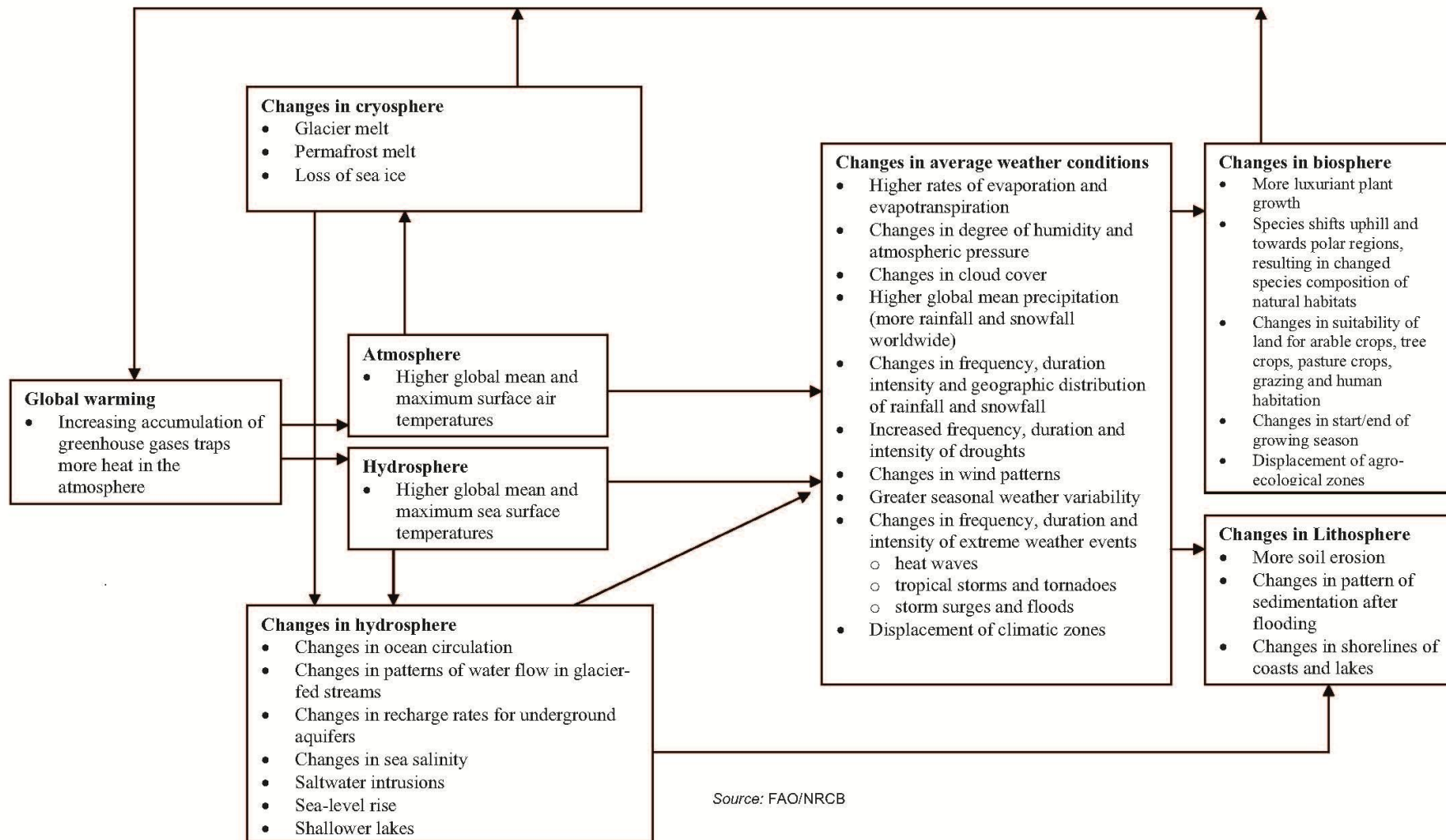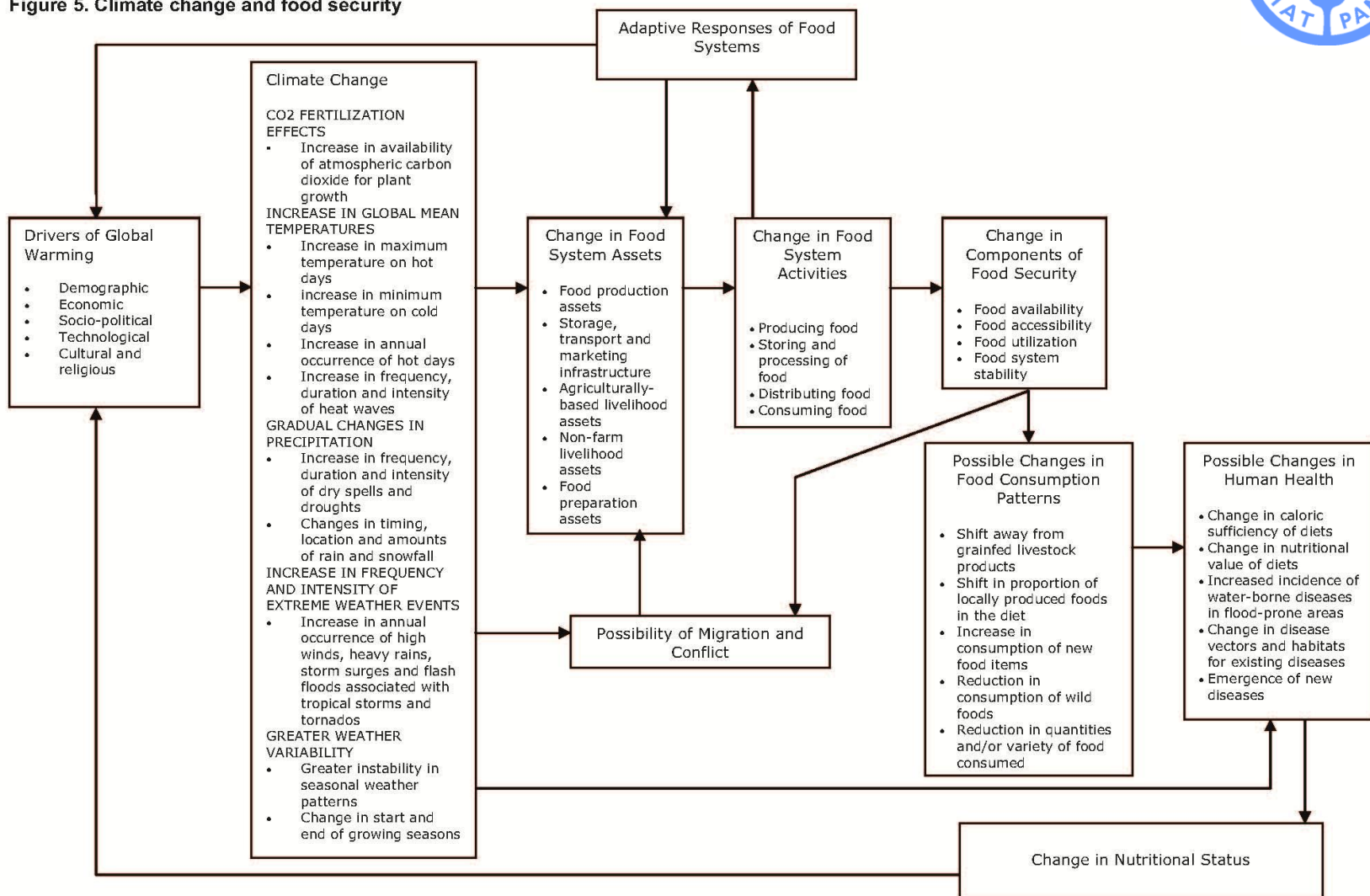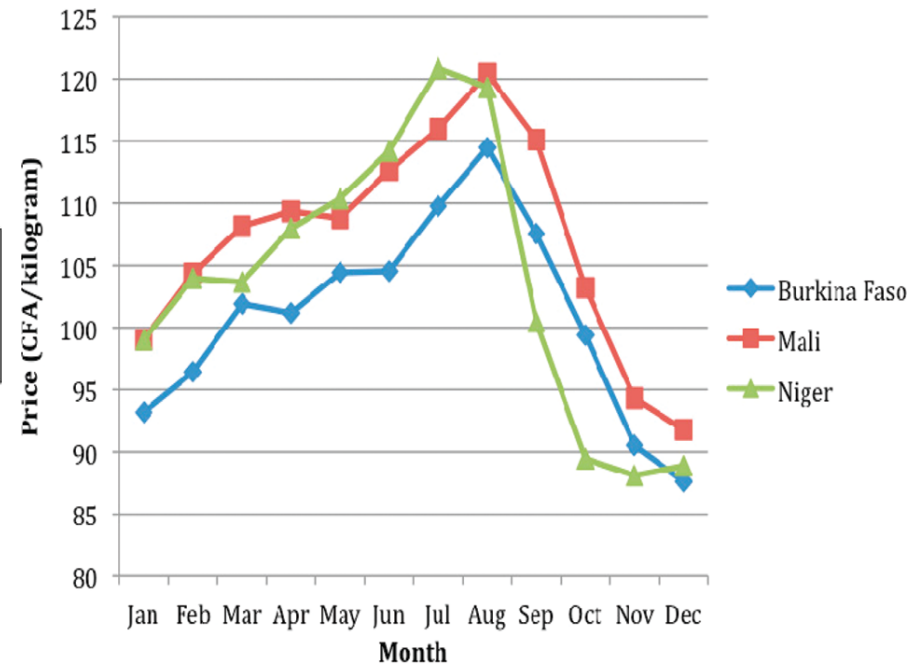
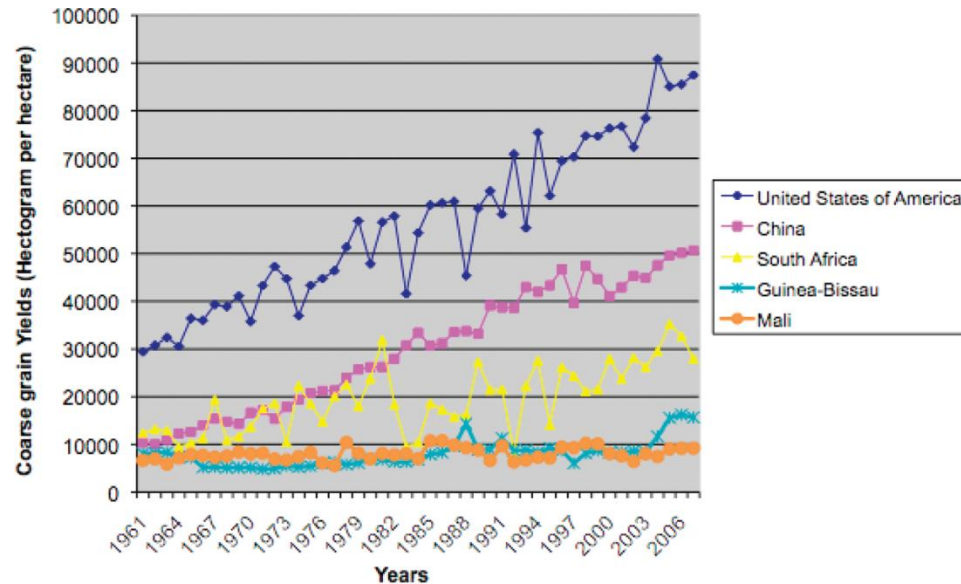**Figure 4. Global warming and changes in the climate system**

Changes in cryosphere
- Glacier melt
- Permafrost melt
- Loss of sea ice

Global warming
- Increasing accumulation of greenhouse gases traps more heat in the atmosphere

Atmosphere
- Higher global mean and maximum surface air temperatures

Hydrosphere
- Higher global mean and maximum sea surface temperatures

Changes in hydrosphere
- Changes in ocean circulation
- Changes in patterns of water flow in glacier-fed streams
- Changes in recharge rates for underground aquifers
- Changes in sea salinity
- Saltwater intrusions
- Sea-level rise
- Shallower lakes

Changes in average weather conditions
- Higher rates of evaporation and evapotranspiration
- Changes in degree of humidity and atmospheric pressure
- Changes in cloud cover
- Higher global mean precipitation (more rainfall and snowfall worldwide)
- Changes in frequency, duration intensity and geographic distribution of rainfall and snowfall
- Increased frequency, duration and intensity of droughts
- Changes in wind patterns
- Greater seasonal weather variability
- Changes in frequency, duration and intensity of extreme weather events
  - heat waves
  - tropical storms and tornadoes
  - storm surges and floods
- Displacement of climatic zones

Changes in biosphere
- More luxuriant plant growth
- Species shifts uphill and towards polar regions, resulting in changed species composition of natural habitats
- Changes in suitability of land for arable crops, tree crops, pasture crops, grazing and human habitation
- Changes in start/end of growing season
- Displacement of agro-ecological zones

Changes in Lithosphere
- More soil erosion
- Changes in pattern of sedimentation after flooding
- Changes in shorelines of coasts and lakes

Source: FAO/NRCB

Figure 5. Climate change and food security

Adaptive Responses of Food Systems

Climate Change

CO2 FERTILIZATION EFFECTS
- Increase in availability of atmospheric carbon dioxide for plant growth

INCREASE IN GLOBAL MEAN TEMPERATURES
- Increase in maximum temperature on hot days
- increase in minimum temperature on cold days
- Increase in annual occurrence of hot days
- Increase in frequency, duration and intensity of heat waves

GRADUAL CHANGES IN PRECIPITATION
- Increase in frequency, duration and intensity of dry spells and droughts
- Changes in timing, location and amounts of rain and snowfall

INCREASE IN FREQUENCY AND INTENSITY OF EXTREME WEATHER EVENTS
- Increase in annual occurrence of high winds, heavy rains, storm surges and flash floods associated with tropical storms and tornados

GREATER WEATHER VARIABILITY
- Greater instability in seasonal weather patterns
- Change in start and end of growing seasons

Drivers of Global Warming
- Demographic
- Economic
- Socio-political
- Technological
- Cultural and religious

Change in Food System Assets
- Food production assets
- Storage, transport and marketing infrastructure
- Agriculturally-based livelihood assets
- Non-farm livelihood assets
- Food preparation assets

Change in Food System Activities
- Producing food
- Storing and processing of food
- Distributing food
- Consuming food

Change in Components of Food Security
- Food availability
- Food accessibility
- Food utilization
- Food system stability

Possibility of Migration and Conflict

Possible Changes in Food Consumption Patterns
- Shift away from grainfed livestock products
- Shift in proportion of locally produced foods in the diet
- Increase in consumption of new food items
- Reduction in consumption of wild foods
- Reduction in quantities and/or variety of food consumed

Possible Changes in Human Health
- Change in caloric sufficiency of diets
- Change in nutritional value of diets
- Increased incidence of water-borne diseases in flood-prone areas
- Change in disease vectors and habitats for existing diseases
- Emergence of new diseases

Change in Nutritional Status

SOURCE: FAO/NRCB.
Figure produced for this report.

Markets, Climate Change, and Food Security in West Africa (Brown, Hintermann, Higgins)

Effects of climate change difficult to predict, but possible reduction of agricultural production up to 50% by 2020: increase resilience!

Increase agricultural production: affordable technology, financial assistance, high-yielding agricultural seeds and fertilizer, small-scale storage facilities, mobile phone fund transfers, microloans + crop insurance, community-based natural resource programs.

Empowerment of local communities

Community mapping initiatives: Google (H2O) and World Bank

Mapping & visualization in general:
importance of knowing what is where

Example: World Bank 'mapping for results' @
maps.worldbank.org & aiddata.org *(tracking development finance)*

Crop modelling: better information provision to improve quantity and quality of production.

References:

Bridging the rural digital divide

"e-Agriculture" A Definition and Profile of its Application (FAO, 2005) *description of global trends and FAO policy*

GIEWS workstation (Global Information and Early Warning System) – FAO *description of services offered to 20 countries in Africa, CIS, SE Asia and Central America*

Space Technology Enabled Village Resource Centre (VRC)
description of societal benefit support to villages:
tele-education, tele-healthcare, land and water resources management, tele-fishery, e-governance services and weather services by the Indian Space Research Organization (ISRO)

Food Prices and Markets

FAO: handle protracted crises – long-term assistance, social protection mechanisms (school meals, vouchers), stimulating markets (food-aid through local markets, cash-based schemes)

The State of Food Security in the World (2010)

World Bank / IMF : better manage risks and reduce future vulnerabilities (insurance, the use of weather derivatives, accurate weather forecasting, warehouse receipts and commodity exchanges, and public stock management)

Responding to Global Food Price Volatility and its Impact on Food Security (2011)

IFC: Global Agriculture Price Risk Management Facility

WFP: earth observation as support tool for food-aid logistics

G20: improve weather forecasting and monitoring, Agricultural Market Information System (AMIS), Global Agricultural Monitoring (GLAM), agriculture and food security risk management toolbox

Action Plan on Food Price Volatility and Agriculture, Ministerial Declaration (2011)

Studies on food prices and markets:

NASA / University of Maryland:

The effect of vegetation productivity on millet prices in the informal markets of Mali, Burkina Faso and Niger (Brown, Pinzon, Prince; 2006) *describes the relation between NDVI and millet prices in West-Africa*

Several Michican State University International Development Working Papers – example:

Spatial Patterns of Food Staple Production and Marketing in South East Africa: Implications for Trade Policy and Emergency Response (Haggblade, Longabaugh, Tschirley; 2009)
analyzes total market and production system,
not only crop modeling
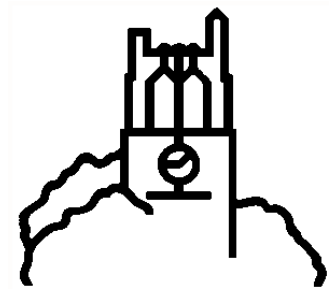
Historical Analysis

Time dimension very important as input for decision-making:

- Crop Modelling
- Climate change monitoring and adaptation
- Change detection (depletion of natural resources)
- Analyzing the effects of different policies, practices, customs, across administrative borders

Example:

SPOT VGT difference products offered by VITO (every 10 days): Scaled Difference Vegetation Index, Vegetation Condition Index, absolute difference, etc.

Improved Prediction

Examples of global systems for prediction of food shortages and timely planning of aid operations:

FEWSNET

GIEWS (FAO)

Global Information and
Early Warning System
- on food and agriculture [GIEWS]

GMFS

FOOD-SEC (MARS)

Improved Prediction

Other examples:

GLAM (global agricultural monitoring project) *timely data delivery, continuity of EO missions, enhanced value added products, yield models, crop area estimates and seasonal weather forecasts, interoperability and better integration of datasets*

Harvest Choice *data harmonization (assembling heterogeneous datasets) + data distribution (new ways of collecting and distributing spatial data)*

CanaSat project *sugarcane area mapping and harvest monitoring (environmental protection) in Brazil*

Insurance

Very much in focus as part of agricultural risk management strategy (**World Bank** reports: Managing Agricultural Production Risk & Agricultural Insurance)

Example of use of earth observation: ADASCIS, Belgium
The use of remote sensing and agrometeorological modelling for crop damage & risk assessment in support of the Belgian Calamity Fund

Business model **developed countries**: **more about income transfers then about risk management** – indemnities paid about equal to total premiums collected, but administrative and operation costs not taken into account.

Insurance

Index-based, weather-related agricultural insurance

Based on: rainfall or **NDVI** – Spain, Canada, Mongolia, Kenya, Mexico (all pasture / rangeland -> for crops apparent low correlation NDVI and yields) or **evapotranspiration** – Food Early Solutions for Africa (FESA) in experimental stage

Should be:
observable and easily measured, objective, transparent, independently verifyable, reportable in a timely manner & stable and sustainable over time

Products best suited for:
homogeneous areas, systemic risk at the aggregated level (reinsurance)

Historical analysis (weather, crops) is important

Insurance

References and case studies:

The Potential for Scale and Sustainability in Weather Index Insurance *for Agriculture and Rural Livelihoods (IFAD, WFP)*

Insurance as an Adaptation Measure to Climate Variability in Agriculture *(CEIGRAM, Spain)*

Comprehensive Risk Cover through Remote Sensing Techniques in Agriculture Insurance for Developing Countries: *a pilot project (India)*

Providing index-based agricultural insurance to smallholders: *recent progress and future promise (Univ. of California, Berkeley)*

Agricultural Insurance Schemes *(JRC, European Union)*

Insurance

References and case studies (continued):

Index Based Livestock Insurance for Northern Kenya's Arid and Semi-Arid Lands: *the Marsabit Pilot (ILRI & partners) +*
Designing Index Based Livestock Insurance for Managing Asset Risk in Northern Kenya

Index Based Agricultural Insurance in Developing Countries: *Feasibility, Scalability and Sustainability (Montana State University)*

Science-based insurance *(Brown, Osgood, Carriquiry)*

Contributions of Agricultural Systems Modeling to Weather Index Insurance *(Baethgen et al)*

State of Knowledge Report – Data Requirements for the Design of Weather Index Insurance: *Innovation in Catastrophic Weather Insurance to Improve the Livelyhood of Rural Households (GlobalAgRisk)*

Insurance

Farmers perception:
Difficulty in understanding index-based concepts, what satellite images can do and concerns about visualizing satellite-based indices + calculating mean vegetation when sowing dates are different

Local companies experience:
Calculating NDVI is expensive (one-off for GIS company)

Other Risk Management

Comprehensive Food Security and Vulnerability Analysis (CFSVA)
Baseline mapping
Agricultural monitoring: background information, estimation of area cultivated, yield estimation (all include historical analysis)
Disaster assessment
Operational planning

Other example:
Locust Habitat Monitoring for GIEWS *(see also disaster management toolkit)*

2. Steps to promote earth observation for crop modelling

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.

References

- **Western Australia: WA Agriculture Climate Science**

- **FAO: Climate Change and Food Security: a framework document**

  Added value earth observation:
  Crop modelling is one of the contributors to food security (as part of value chain management),
  Facilitates implementation of insurance schemes,
  Helps manage water more efficiently,
  Supports sustainable land management,
  Helps maintaining biodiversity,
  Improves livestock management,
  Improves fishery management.

References (continued)

- **CanaSat** (Brazil) see above

- **e-Leaf** (eleaf.com) *offers integrated agricultural services to farmers in the Netherlands and Europe – pilot phase*

- **GEO Task US-09-01a: Critical Earth Observations Priorities *Agriculture Societal Benefit Area*** *global overview of available observations and what is needed*

  for more examples: have a look at *www.geonetcab.eu*

GLobal Agricultural Monitoring community – GLAM: what is needed?
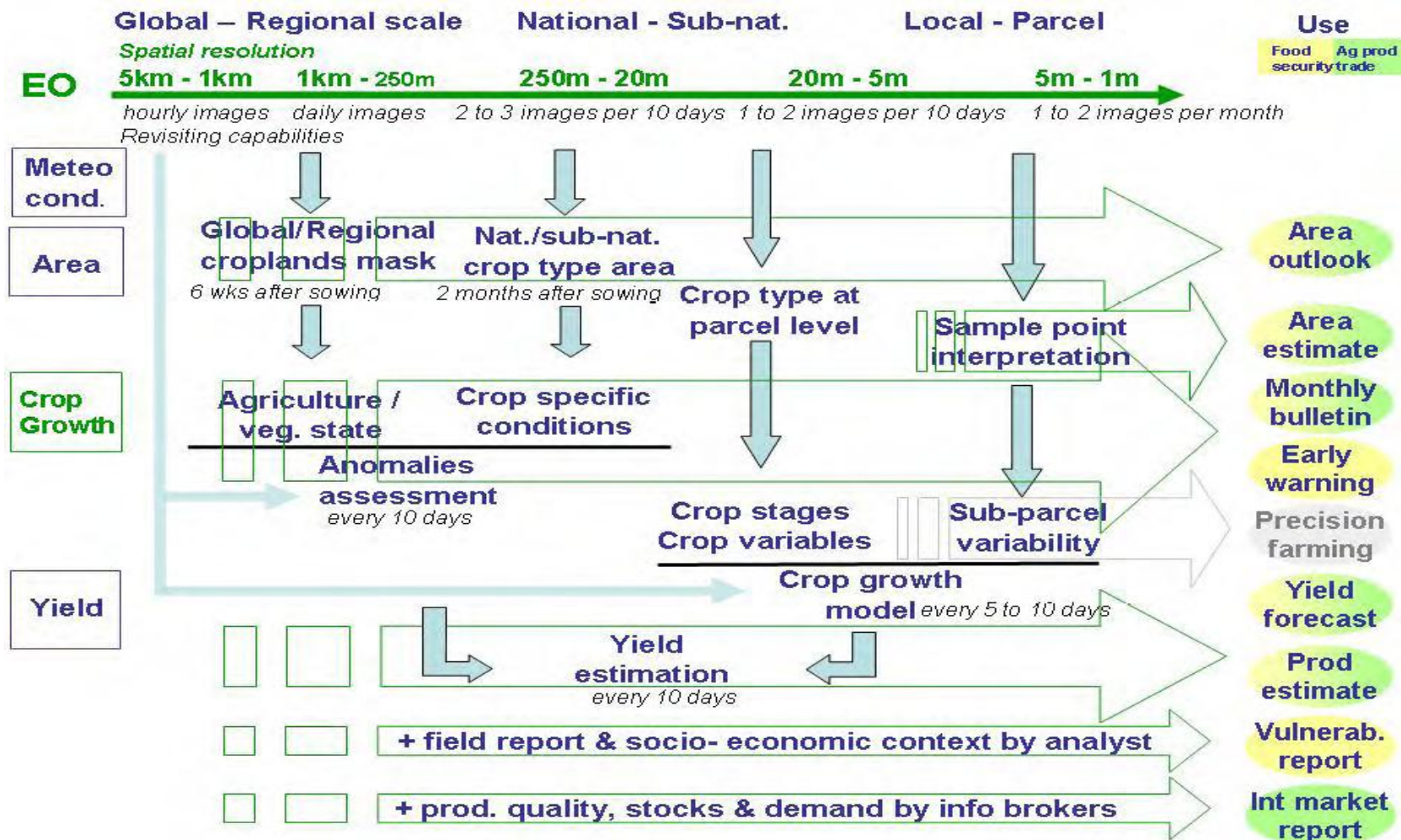
Marketing of earth observation

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? *For crop modelling: see next slides.*
- Identify the problem that they are trying to solve: is it the same as yours?
- Learn to speak the same language. Example: when EO specialists talk about 'food security', experts in other fields consider EO activities as crop modelling. Translate to something the client (or your partner) understands.
- Look for examples from elsewhere (success stories): solutions that work and are affordable.

What users need to serve clients:

- **Accurate and reliable crop production information on specific reporting levels** (national, district)
- **Spatial distribution of cultivated area**
- **Crop growth models**
- **Timely and unbiased production information on main crops**
- **(Timely) availability of satellite data**
- **Good quality meteorological data**
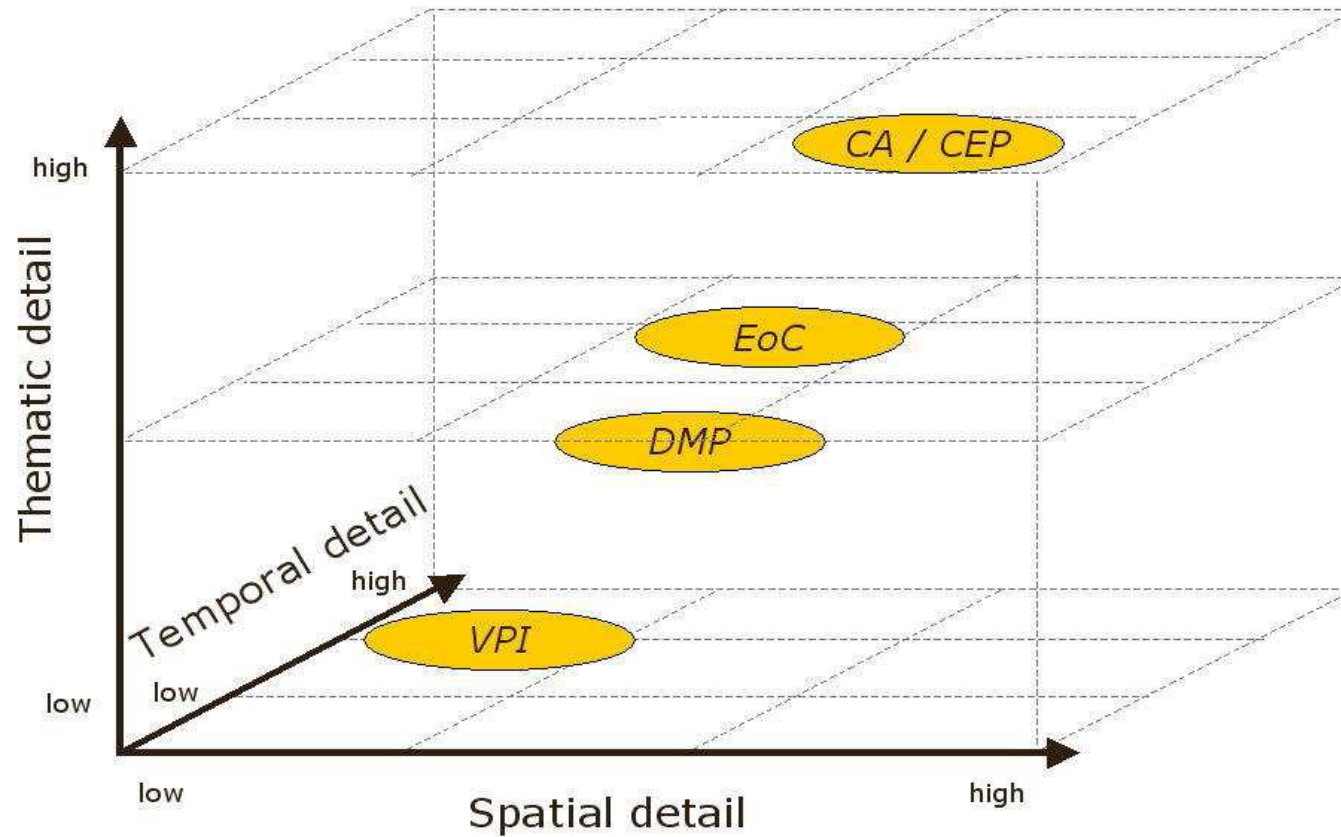- **Capacity building to enable correct use and integration of products and services**

Figure 2: Advanced multi scale crop information services
(GMFS services, CA = Cultivated Area; CEP = Crop Emergence Period; EoC = Extent of Cultivation;
DMP = Dry Matter Productivity; VPI= Vegetation Productivity Indicator).

Maturity of EO Services

Early warning: fully operational

Cultivated area: further development needed *(timely delivery of data, technical complexity)*

Extent of cultivation: accuracy needs to be improved for good local results *(district, farm)*

Crop yield forecasting: fully operational

Index-based insurance: better results for rangeland than for crops, especially for smallholders *(NDVI-based, cloud cover a problem)*

Precision agriculture: still in pilot phase *(cloud cover in critical months of the growing season is a problem)*

Costs of EO Services for crop modelling / food security support

Service	Definition of Unit Service	Cost (k€)
Early Warning Service	Annual coverage of Africa with suite of early warning indicators, at 10-day update frequency	230
Agricultural Mapping	Validated map of cultivated area (10 – 20 m resolution) per 100 000 km^2	175
Crop Yield Assessment	Yield forecast for 2-3 main crops, for 100 000 km^2	85
Support to CFSVA	Support to one CFSVA mission	35

very global estimate, includes development for specific user needs and training

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

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

AGRICAB project (follow-up of DevCoCast and GMFS)
optical remote sensing, radar remote sensing, agro-meteorological modelling, food security information systems, product validation

GEONetCab capacity building web www.geonetcab.eu

compilation of tutorials, references, open-source software, etc.

GEO Portal: www.earthobservations.org

Focal points: cheaper processing of NDVI calculations, ground truthing, historical analysis *(making use of free and open data): integration with other services*

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:

Contact: Mark Noort

m.noort@hcpinternational.com

www.geonetcab.eu