Space for Agriculture and Food Security
Rome, WFP Headquarters, *8-9 March 2012*

Remote Sensing application for agricultural monitoring (Case studies: national assessments)

Renato Cumani
Environment Officer (NRL
John S. Latham
Senior Land and Water Officer (NRL)
Natural Resources Management and Environment Department (NR)
Land and Water Division (NRL)
Food and Agriculture Organization (FAO)

FAO Role

FAO is the United Nations agency responsible for collecting, analyzing, interpreting and disseminating information relating to food, nutrition, agriculture and related subjects

FAO priorities

- improving agricultural production in poor rural communities;
- developing and conserving natural resources;
- expanding rural infrastructure and market access;
- strengthening capacity for knowledge generation exchange;
- ensuring access to food for the neediest.

Utilization of Ancillary data (including the integral use of Remotely Sensed data) is a key component of FAO Monitoring of Agricultural Production

Distribution of main land use categories

	Cultivated land		Grassland and woodland ecosystems		Forest land		Total
	Mha	%	Mha	%	Mha	%	(Mha)
Developed	590	11	1923	37	1726	33	5160
Developing	969	12	2689	33	2009	25	8135
World Total	1559	12	4612	35	3736	28	13295

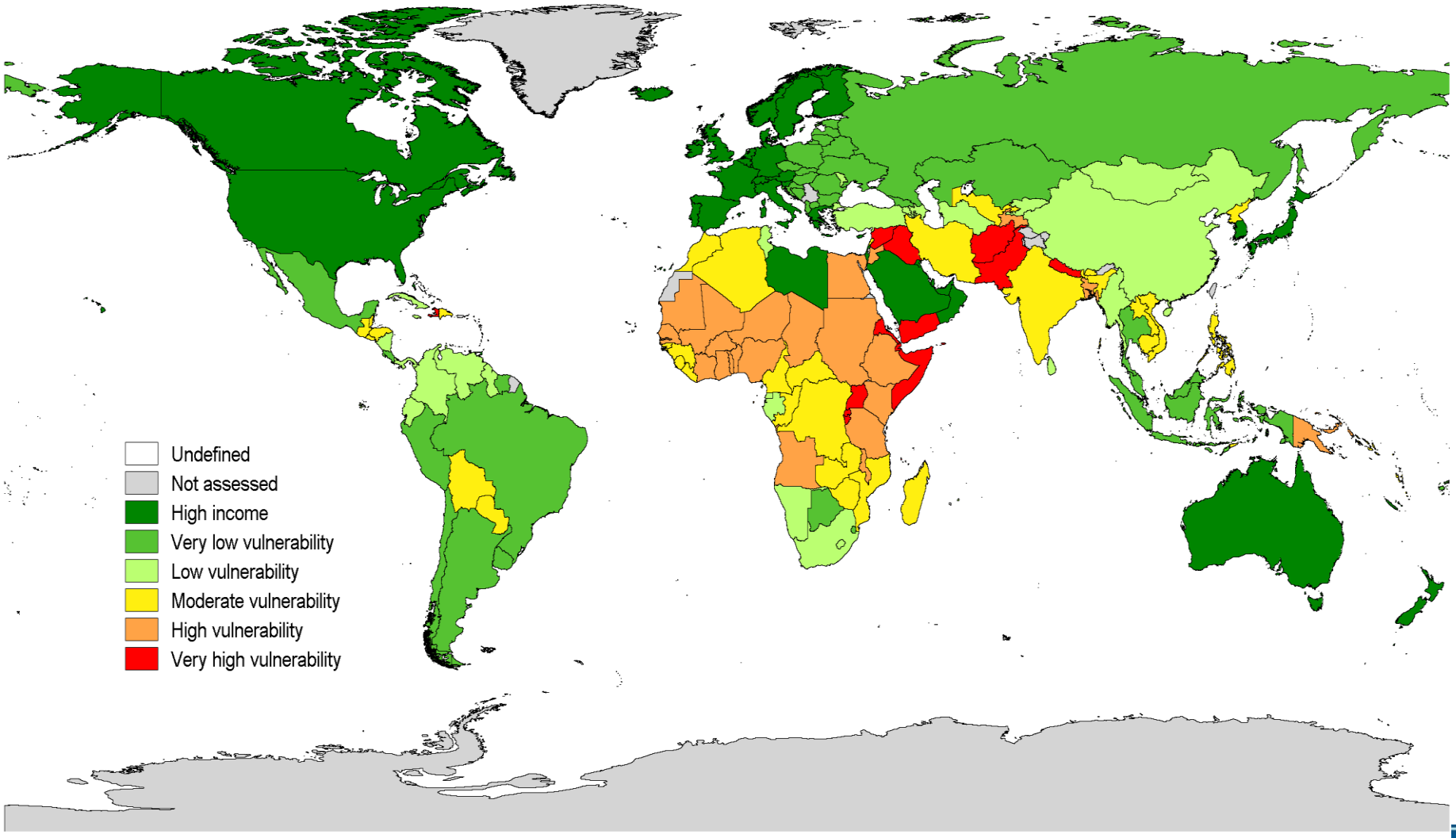
Share of world cultivated land suitable for cropping under appropriate production systems

Region	All land (Mha)	Rain-fed crops (%)		
		Prime land	Good land	Marginal land
Developed	590	34	52	14
Developing	969	25	53	22
World Total	1559	28	52	19

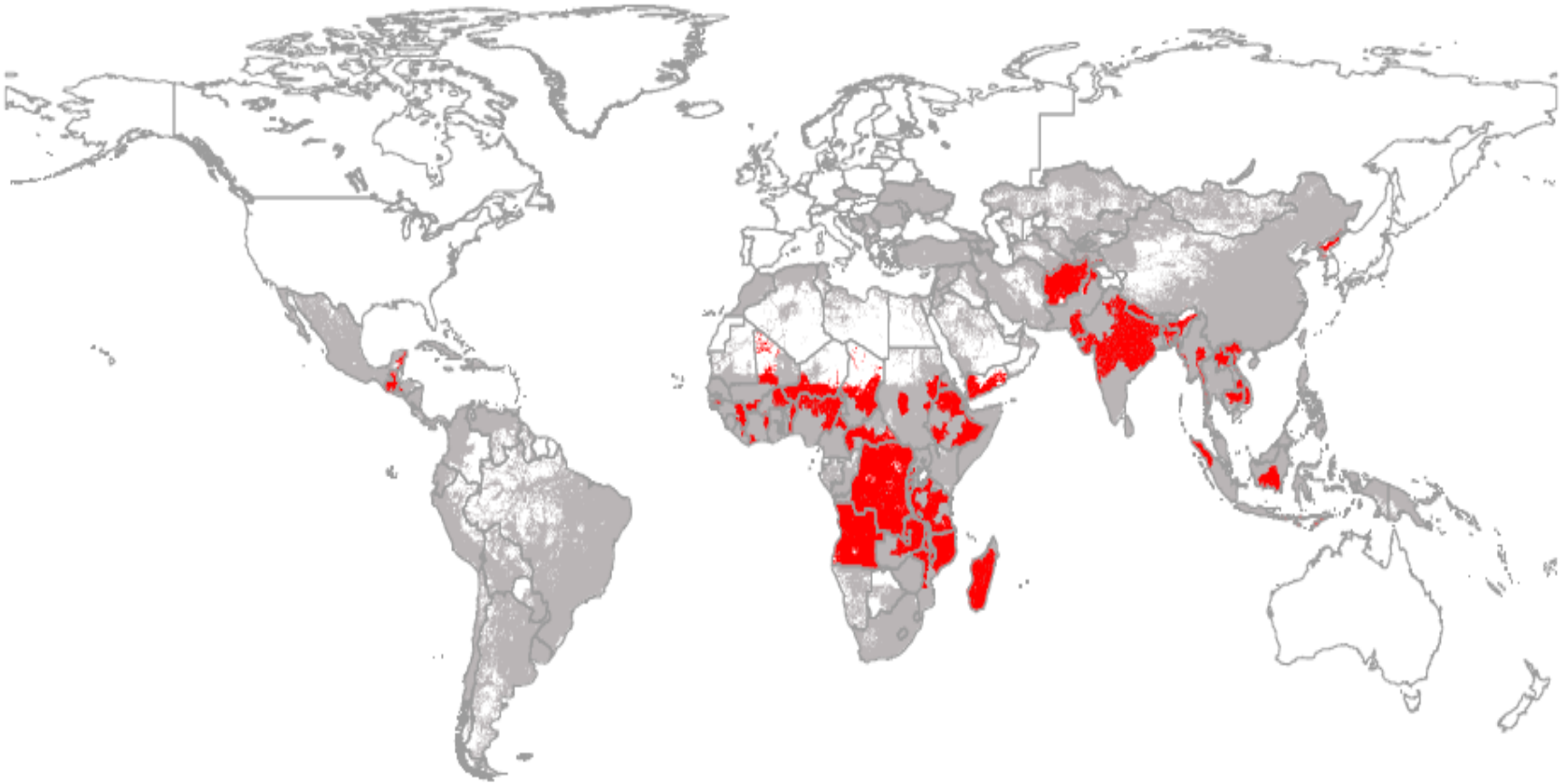
Net changes in major land use (million ha)

	1961	2009	Net increase 1961-2009
Cultivated land	1,368	1 527	12%
Rain-fed	1,229	1,226	- 0.2%
Irrigated	139	301	117%

Countries vulnerable to food insecurity

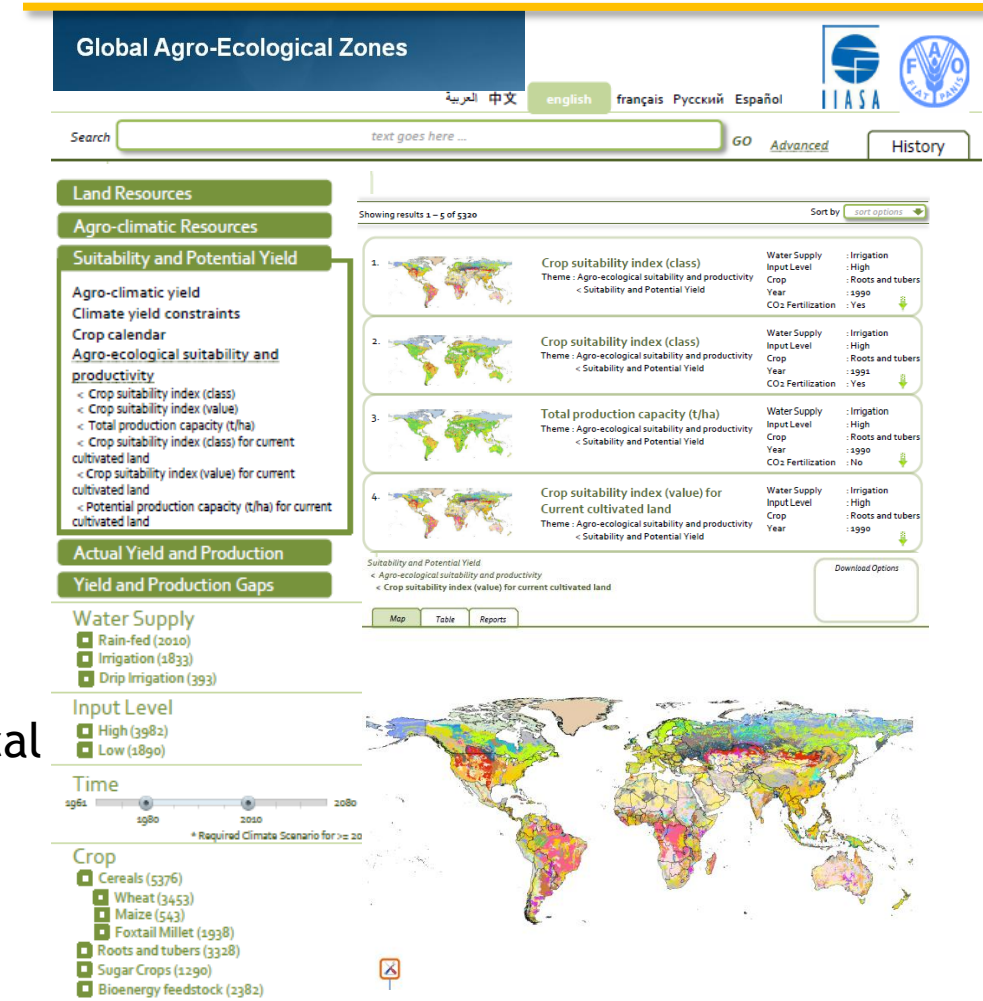


Where the rural poor are concentrated



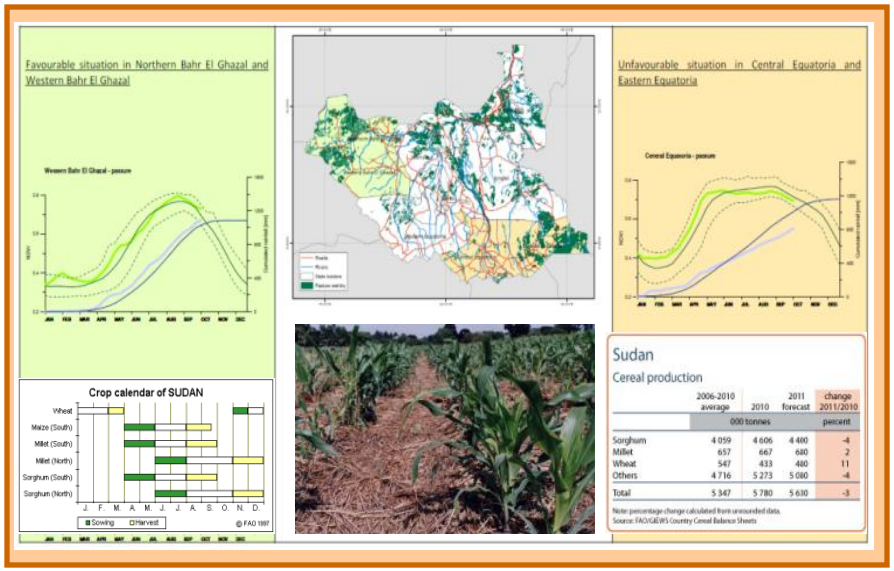
GAEZ Initiative

- For assessing agricultural resources and potential
- Developed by FAO and IIASA
- Five major thematic areas:
  - *Land and water resources,*
  - *Agro-climatic resources,*
  - *Suitability and potential yields, actual yields*
  - *Area harvested and production,*
  - *Yield and production gaps*
- 280 crops and crop groups, water supply, inputs, time period –historical 1961-1990, “current”- 2000 and future, 2020s, 2050s, 2080s – data will be progressivley updated.
- More than 24 TB of data and information



Agricultural Monitoring, Remote Sensing and FAO

- Long history in FAO;
- EO data used to monitor the cropping season in some priority areas/countries. Not a routine activity for all areas more collaboration is needed
- Analysis is at HQ; Regional Offices and local levels - especially in member countries: National Capacity development is a fundamental part of building sustainable monitoring systems



Applications of Remote Sensing

Coarse resolution satellite imagery:

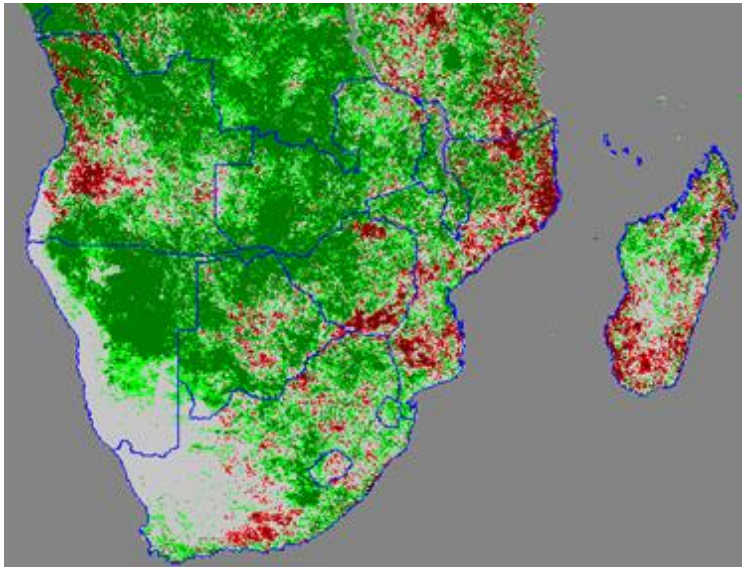
1. Monitor the state of vegetation (NDVI) in cultivated and rangeland areas
2. Monitor the rainy season and identify areas which are likely to have suffered from or might be affected by, drought or excessive rainfall.

Medium/High resolution satellite imagery:

1. Estimate/Forecast yields of major crops
2. Estimate the extent of cultivated land

Normalized Difference Vegetation Index (SPOT-4)

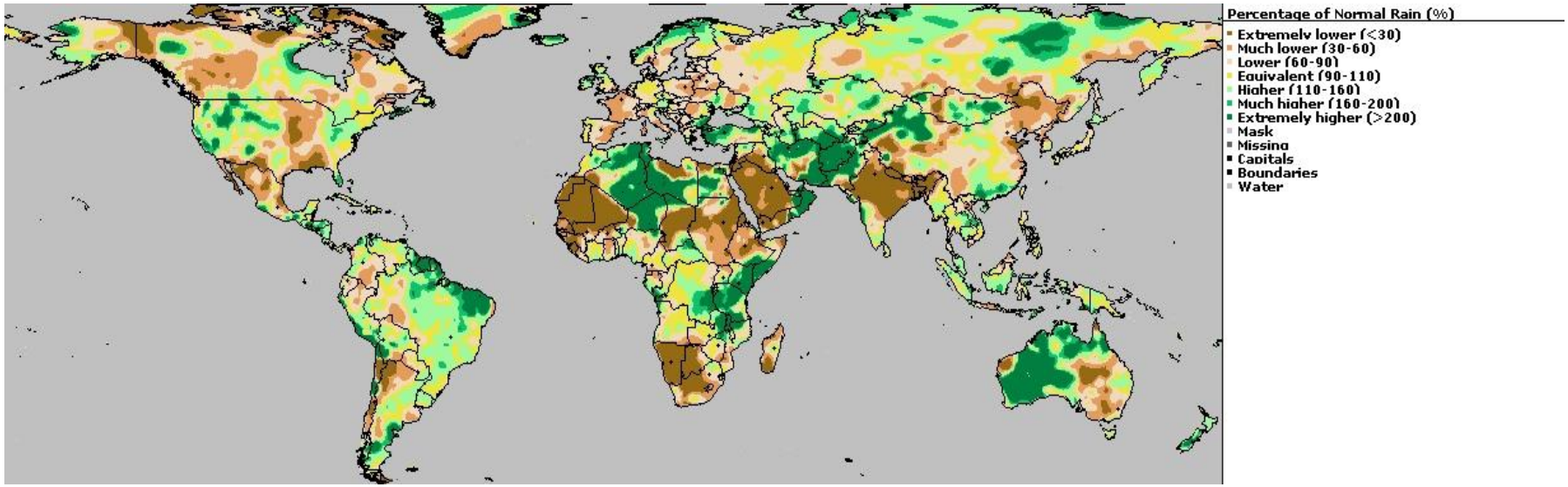
Difference between Current Dekad and Average (1998-2004) FAO - ARTEMIS



Global Precipitation Indices for Agriculture

Agriculturally relevant precipitation indices: deviation from normal, water stress, agriculture season length, etc.;

- **Provide continuous information on value added variables relevant to decision making at the regional and national level**
- Provide information on progress of the precipitation indices from the past to current



Agricultural Stress Index (ASI): in progress

Objectives

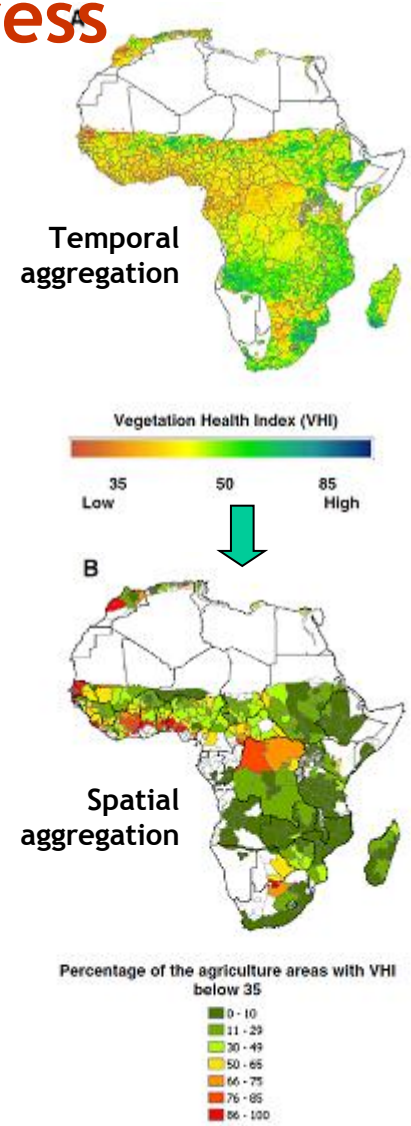
To provide GIEWS with crop and vegetation monitoring tools for fulfilling the early warnings activities based on the real time remote sensing information

The system proposed will guarantee independence and autonomy of analysis in data acquisition

Main characteristics of the ASI system

- ASI will run automatically at GLOBAL level using the METOP remote sensing imagery free of charge (1 km resolution)
- The vegetation index will be integrated temporal and spatial in the agricultural areas
- Final output will be GLOBAL quick look maps (every 10-day) showing the hot spots of agricultural areas probably affected by drought

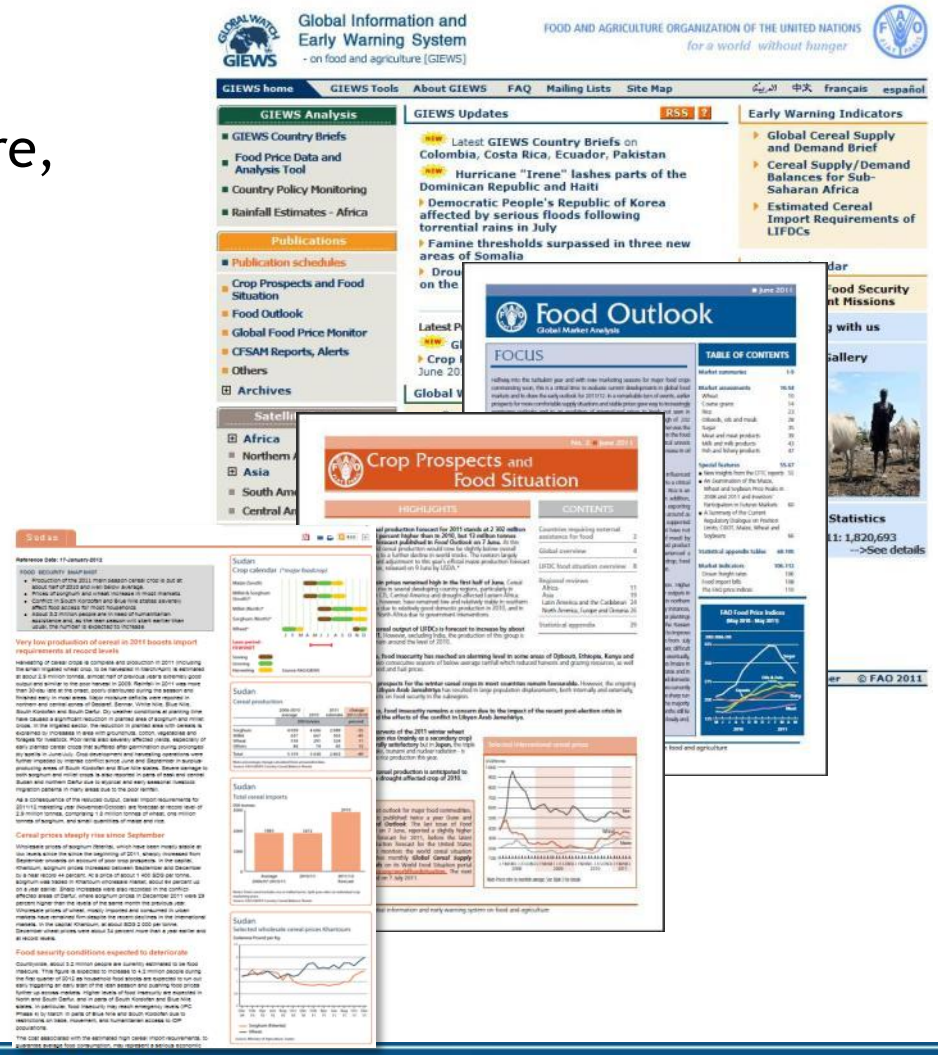
Developed in collaboration with VITO and EU-JRC



GIEWS Initiative and Products

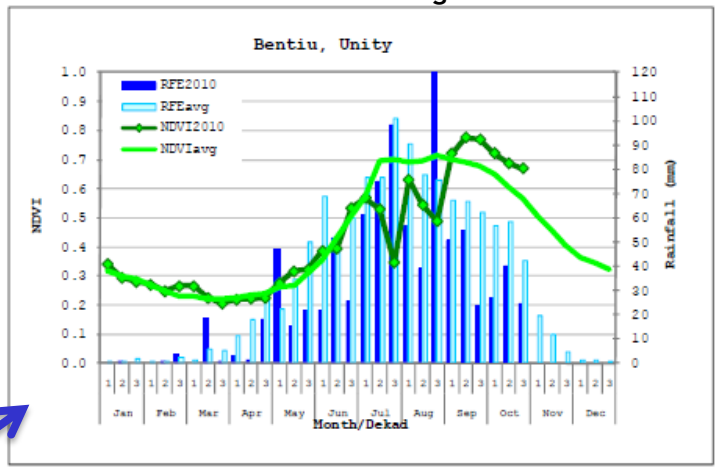
Cereal production forecasts and vegetation conditions, both to monitor crop conditions and pasture, especially in sub-Saharan Africa countries, are substantiated with analysis based on Remote Sensed data (RFE, NDVI…).

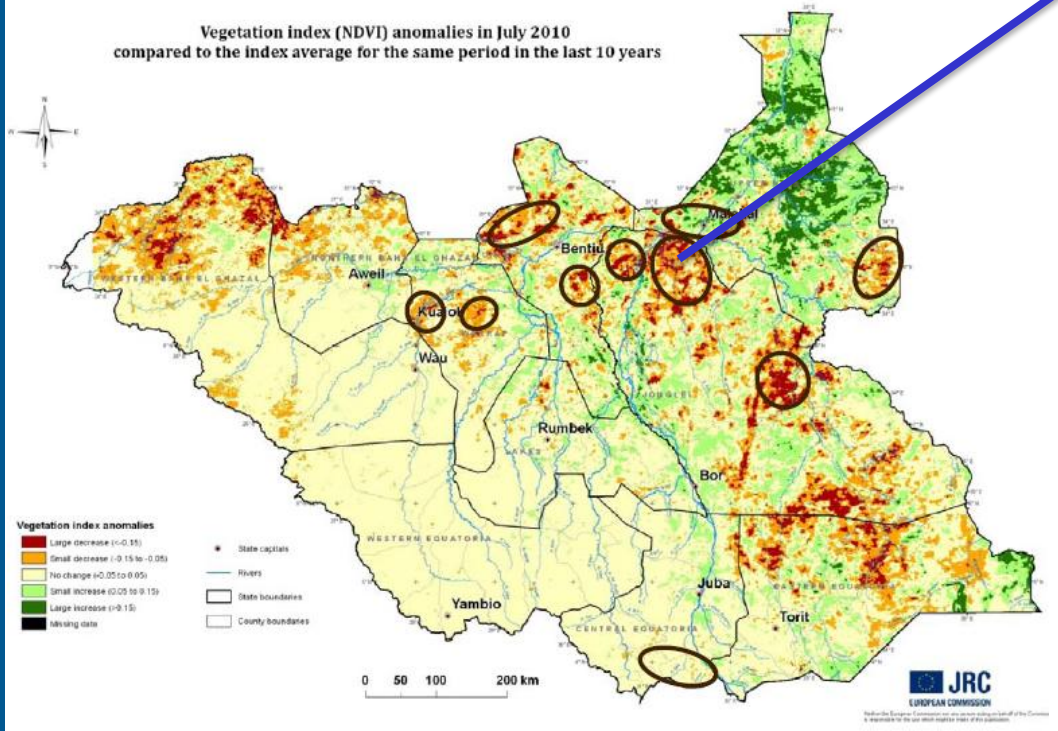
- **Crop Prospects and Food Situation**
- **Food Outlook**
- **On-line Country Briefs**
- **Special Reports and Alerts**



Southern Sudan 2012 Crop and Food Security Assessment Mission - CFSAM

Rainfall distribution and vegetation indices





NDVI and RFE analysis was important for identification of areas at risk from drought

It helps prioritize field trips and improve estimates of production in areas that could not be visited

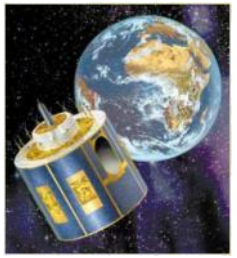
Key variables/information for crop monitoring & production forecasting

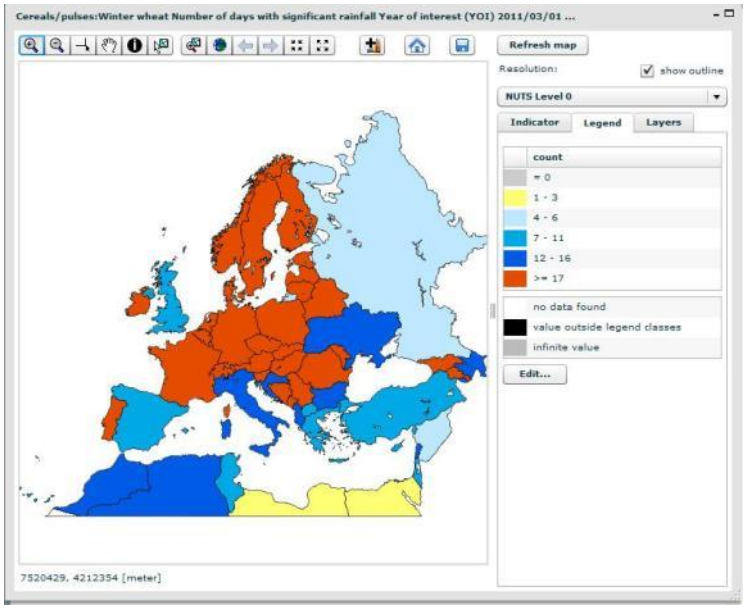
- Input availability
- Planted areas
- Pests and diseases
- Policies
- Meteorological data
- Crop condition

Supported by FAO's Natural Resources and Environment Department

Remote sensing

- Estimated rainfall
- NDVI





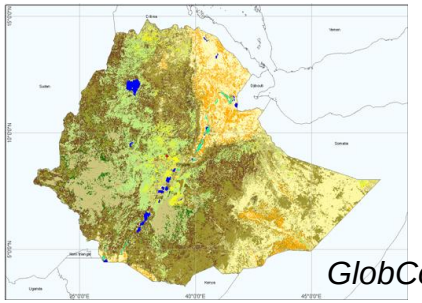
Enhancing National Capacity for Agricultural Monitoring

- **Requirements at country level:**
  - Up-to-date land cover and especially cropland area mapping is fundamental on a regular basis
  - Robust area frame sampling design, refined with land cover as a basis for stratification and sample allocation
  - Improved rainfall estimation and soil moisture conditions need to be tested and made operationally available
  - Improved estimation of area planted seasonally and field validated needs to become a regular product of our community
  - Crop type and condition monitoring needs to be improved
  - Improved yield estimation needs to be put in place and lessons learnt

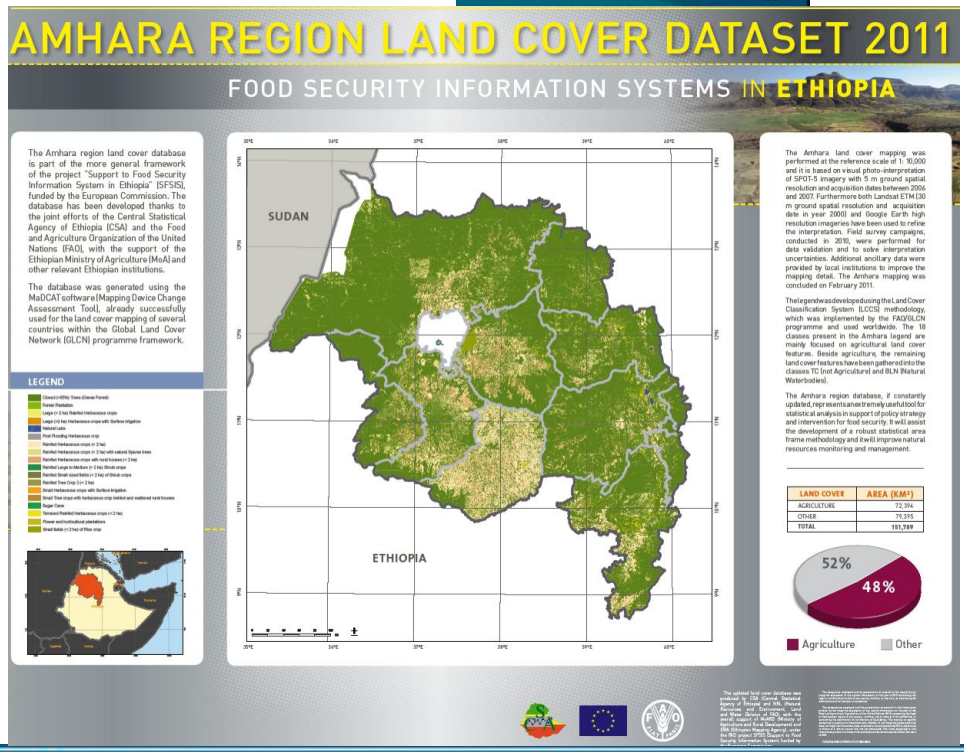
HOW TO SCALE UP ?: - A community of practioners, working in partnership, can be more successful if this is tackled collectively.

National land cover mapping

- Standardized and harmonized land cover baseline; built on International standards - LCCS
- Updated databases are an important component of many environmental applications but also for:
  - National agricultural analysis
  - Natural Resources monitoring
  - Strengthening National Capacity for Agricultural Monitoring

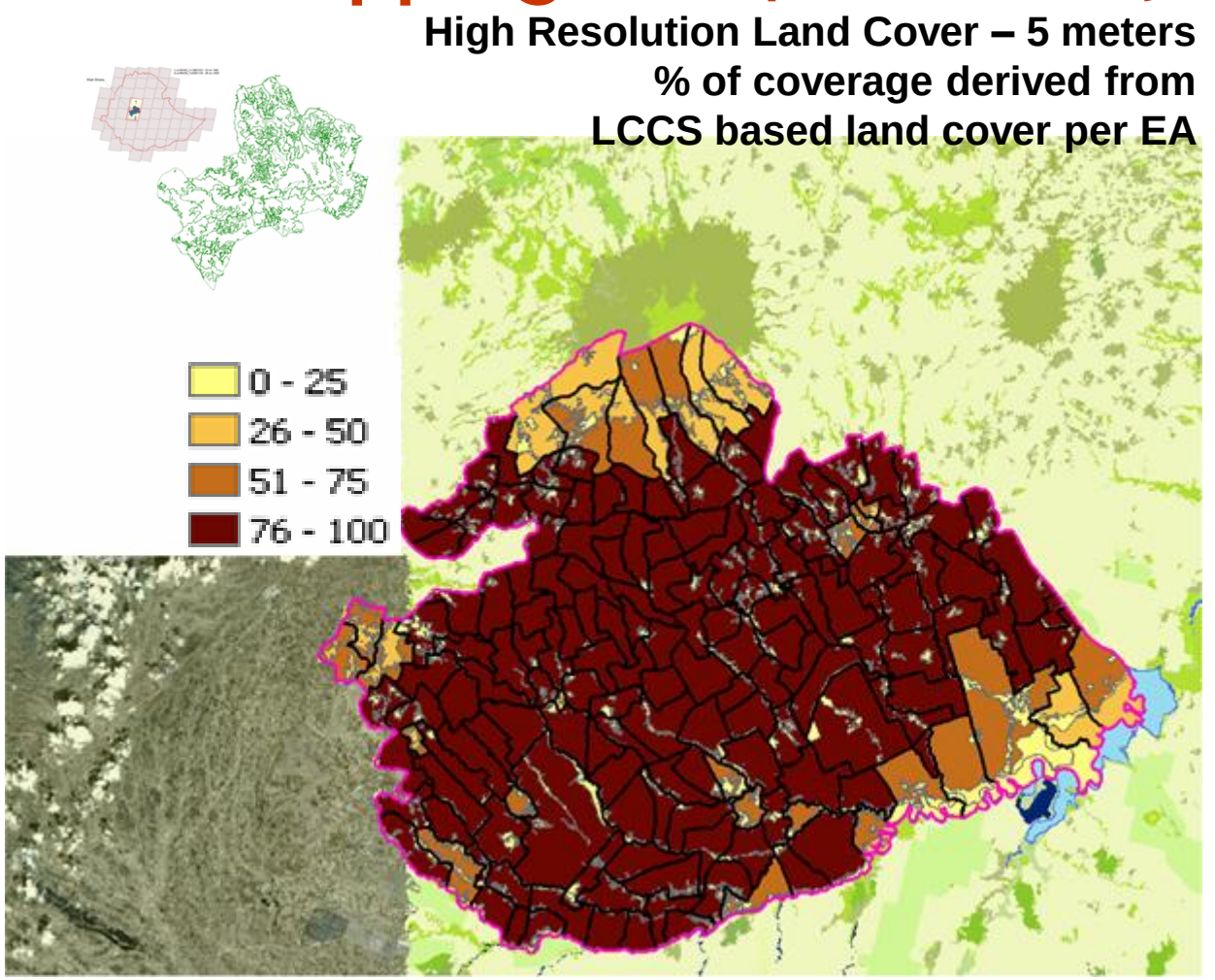


GlobCover 2005/06 Ethiopia

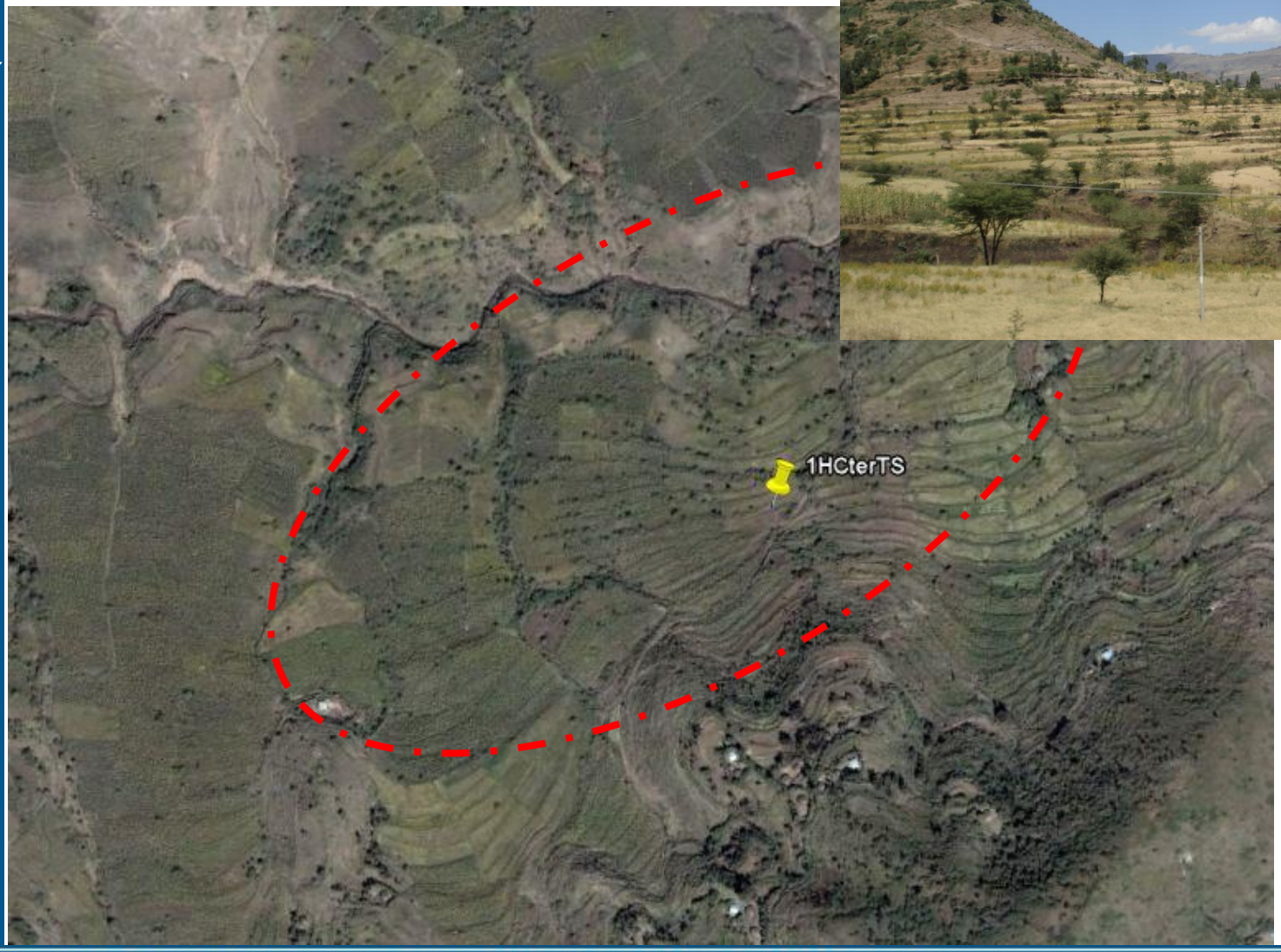


National land cover mapping: Ethiopia case study

- Land cover in agricultural areas using high resolution data, standard procedures and methodologies, and using the FAO Land Cover Classification System (LCCS).
- Sampling design and area frame analysis greatly improved
- More accurate agricultural statistics



Terraced Rainfed Herbaceous Crops with Sparse Trees (< 2 ha)



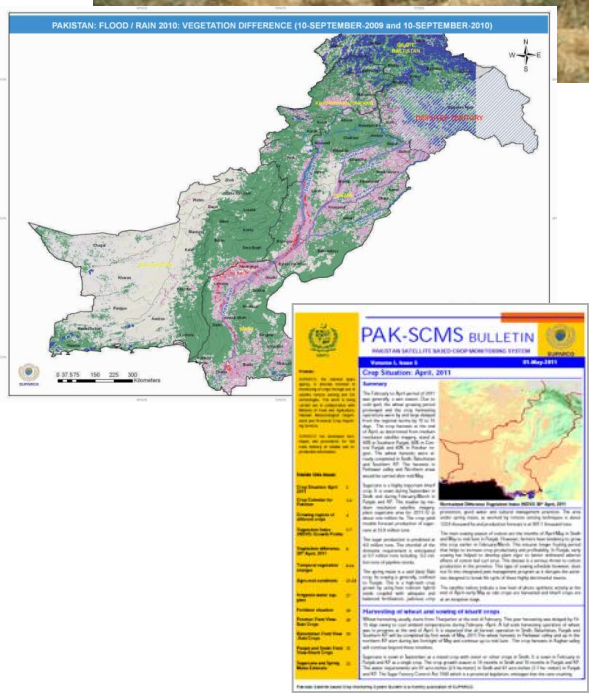
Example of photo-key

Pakistan's Crop Monitoring System

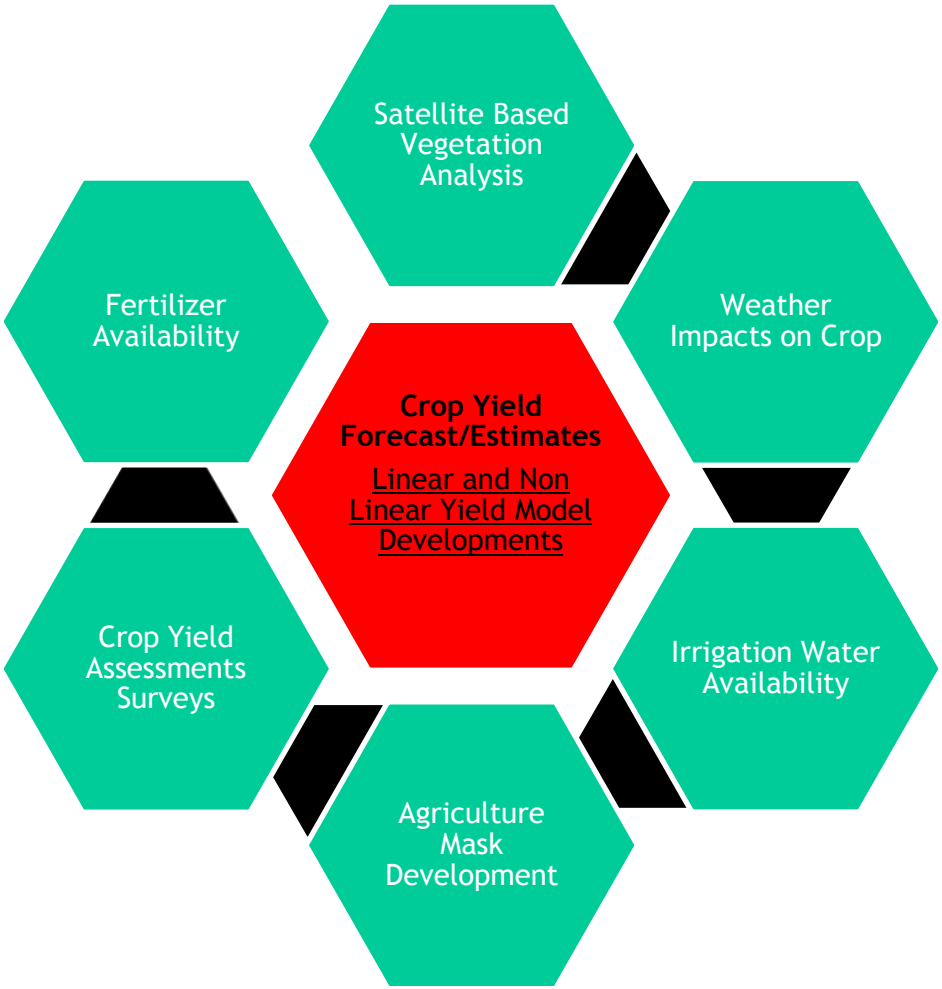
On going project on the improvement of national and provincial capacity to collect and analyze agricultural information and deliver accurate, reliable, timely, precise and cost effective agricultural statistics.

This will be obtained through the:

- integration of remotely sensed data into existing data collection, analysis, and dissemination systems;
- design and implementation of rigorous agriculture and rural survey methods (e.g. area frame and crop yield models);
- promotion of cooperative use and sharing of field data;
- improvement of quality and outlook of current crop forecast/estimation bulletins;
- development of human resources and technical capacities.

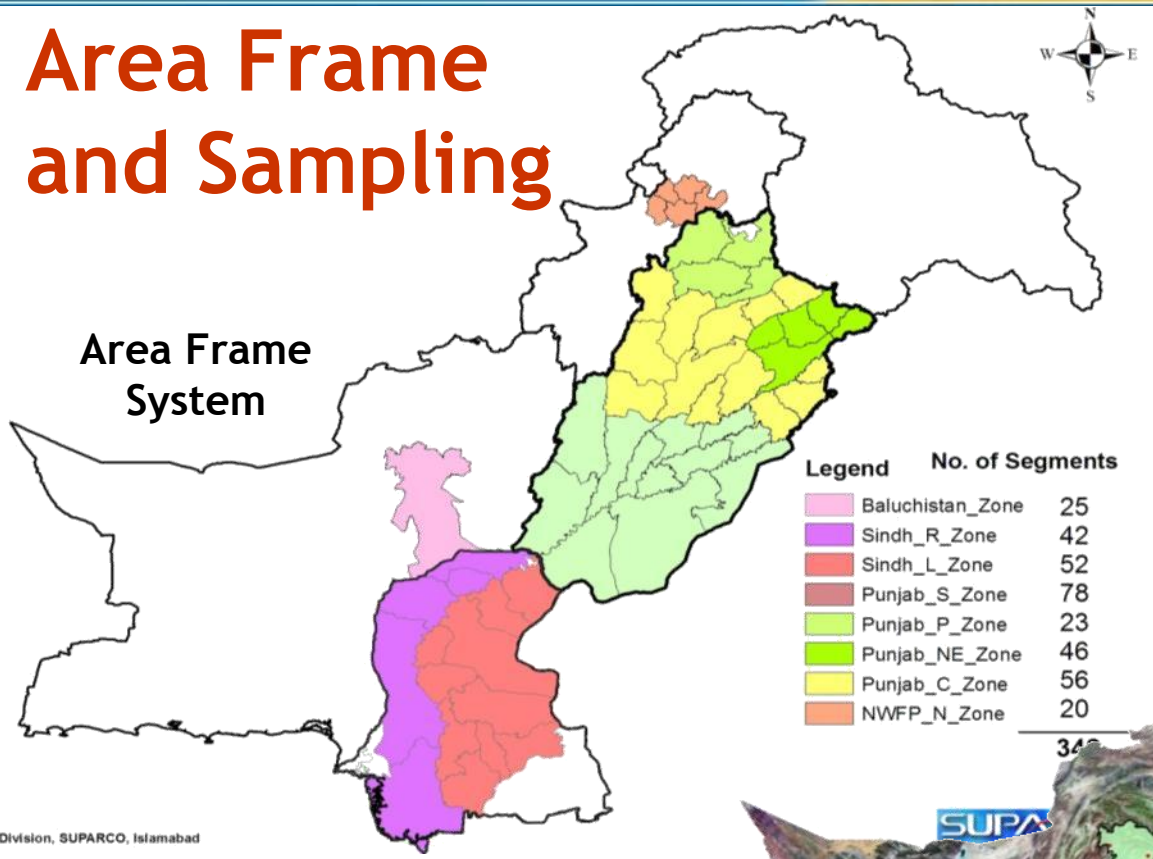


Pakistan System: Model

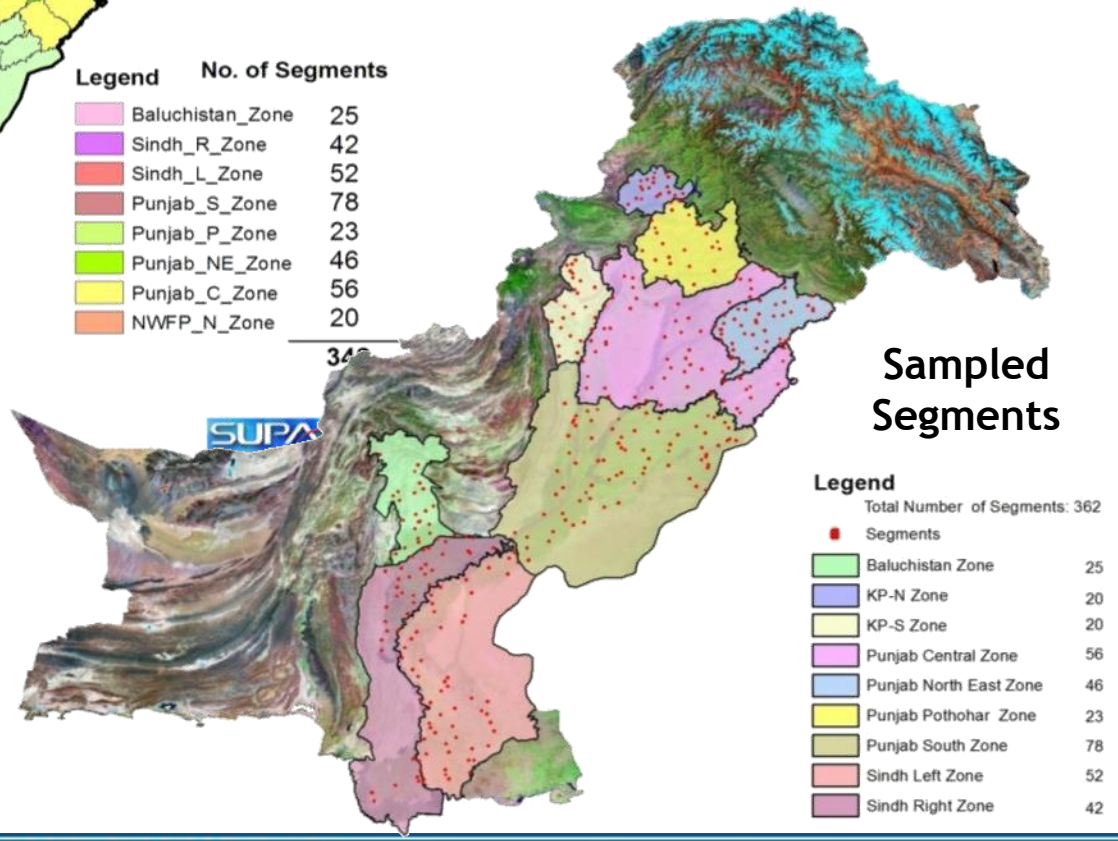


Area Frame and Sampling

Area Frame System



Sampled Segments



Crop Estimates 2010-11 (SUPARCO & CRS)

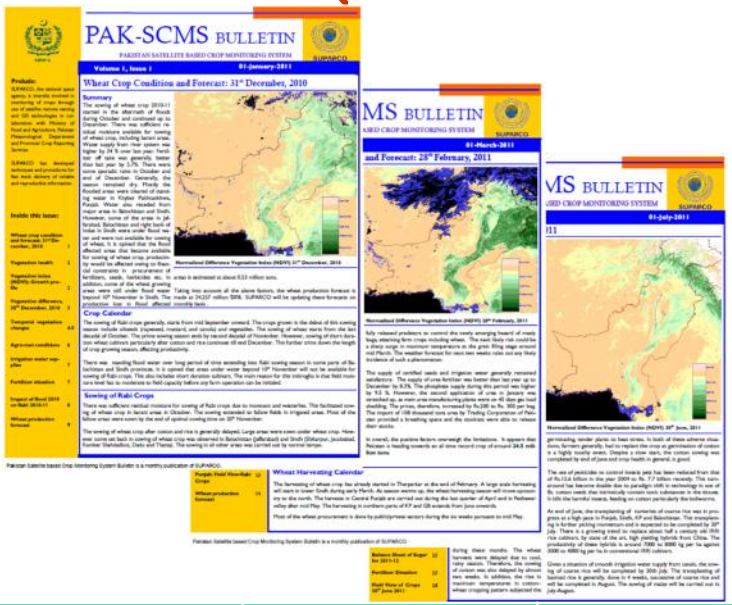
Crop	Variables	Units	2010-2011									
			Punjab		Sindh		Khyber Pakhtunkhwa		Balochistan		National Level	
			SUPARCO	MINFA/CRS	SUPARCO	MINFA/CRS	SUPARCO	MINFA/CRS	SUPARCO	MINFA/CRS	SUPARCO	MINFA/CRS
Wheat	Area	000 ha	6695.0	6690.5	1509.0	1144.4	645.2	724.5	305.0	340.8	9154.2	8900.2
	Yield	kg/ha	2764.0	2845.0	2585.0	3746.9	2015.0	1595.0	1967.9	2140.0	2655.2	2833
	Production	000 tons	18505.0	19041.0	3900.8	4287.9	1300.1	1155.8	600.2	729.1	24306.1	25213.8
Cotton	Area	000 ha	2052.7	2200.6	605.4	457.6	0.0	0.2	32.6	31.3	2690.6	2689.7
	Yield	kg/ha	633.0	606.7	707.0	1316.0	0.0	0.0	521.0	191.0	648.0	722
	Production	000 bales	7643.1	7854.0	2516.1	3536.8	0.0	0.4	99.9	35.2	10259.1	11426.4
Sugarcane	Area	000 ha	873.4	672.2	294.2	226.5	111.1	88.4	-	0.6	1278.7	987.7
	Yield	Tons/ha	55.4	55.8	56.0	60.8	45.0	45.6	-	48.3	54.6	56
	Production	000 tons	48386.3	37481.0	16475.2	13766.4	4999.5	4030.3	-	30.8	69860.5	55308.5
Rice	Area	000 ha	1901.2	1766.8	371.8	361.2	58.4	46.1	70.0	191.2	2401.5	2365.3
	Yield	kg/ha	1965.0	1916.0	3445.0	3406.2	2026.0	1701.0	3364.0	683.0	2236.0	2039
	Production	000 tons	3735.8	3384.0	1281.0	1230.3	118.3	78.4	235.6	130.6	5370.7	4823.3

SUPARCO: Pakistan Space & Upper Atmosphere Research Commission
CRS: Crop Reporting Services

Pakistan Monthly Crop Bulletin (Pak-SCMS)

The monthly bulletin mainly covers:

1. Satellite based Crop Forecast/Estimation
2. Agriculture Situation Analysis – Fertilizer, Irrigation water, agro-meteorology , Market trend lines and others.
3. Seasonal/Crop based NDVI Profiling
4. Temporal Vegetation Change Analysis
5. Natural Hazards if any



Cropping Season	Provinces	SUPARCO
Kharif Crops	1st February	15th October
Rabi Crops	1st August	15th March

Note: The actual reporting time for rabi crops by provinces is the month of November and for kharif crops the month July

Annual Costs of Crop Monitoring

- **Provincial Crop Reporting Services**
  Cost per year (in million US Dollar)

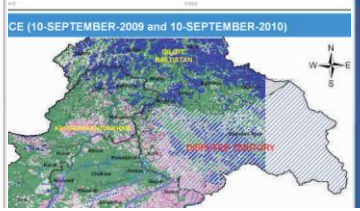
Punjab	$2.2M
Sindh	$0.7M
Baluchistan	$0.8M
Khyber PakhtunKhawa	$0.7M
Total	$4.4M

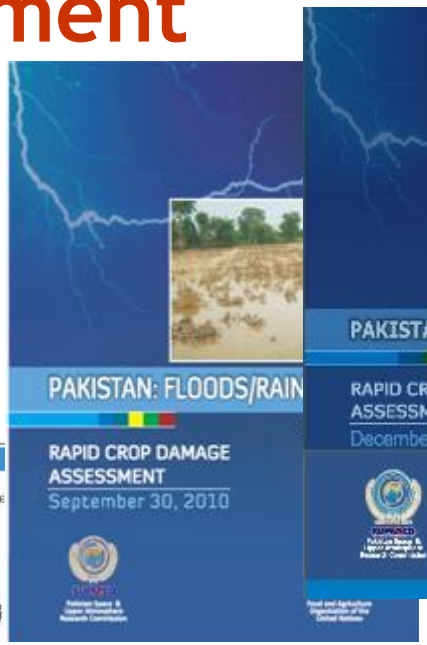
- **Agriculture prog , SUPARCO*** — $0.1M

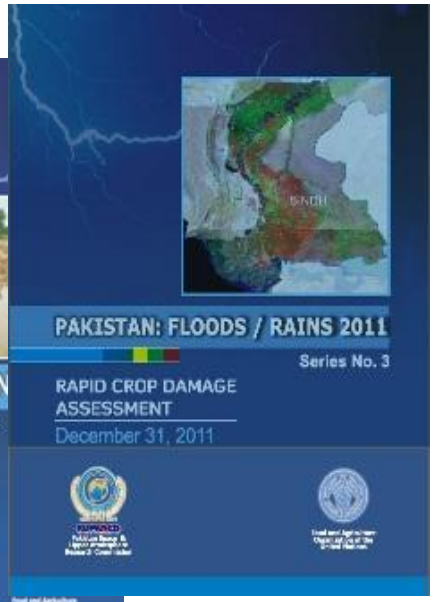
Note: The current cost of satellite imagery is $0.1M.
Usually 104 SPOT 5 scenes are required to cover the total agriculture area of Pakistan.
Agriculture area is covered twice (once for each cropping season).

Rapid Crop Damage Assessment

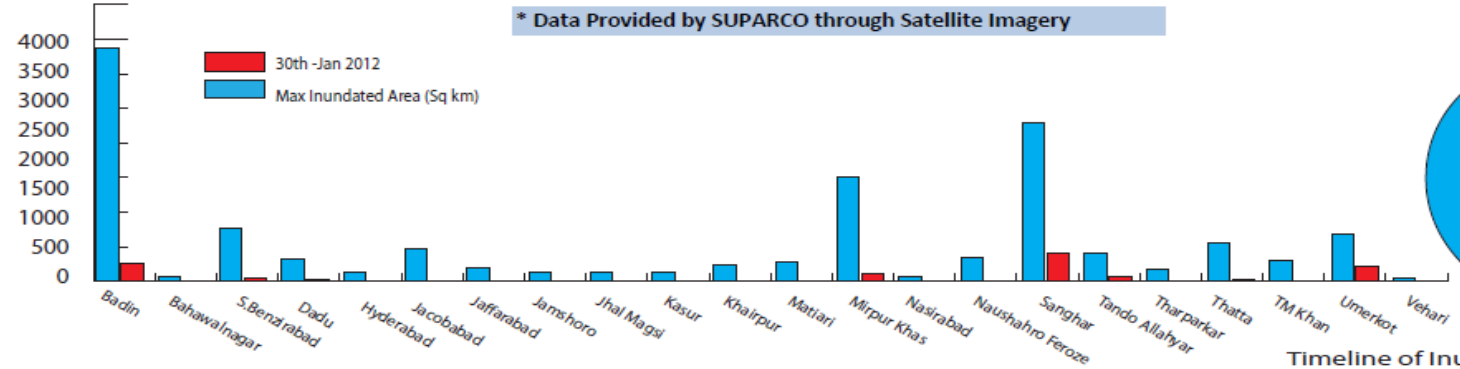
- Monthly bulletins issued by SUPARCO and FAO in collaboration

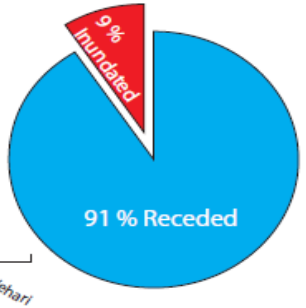






* Data Provided by SUPARCO through Satellite Imagery

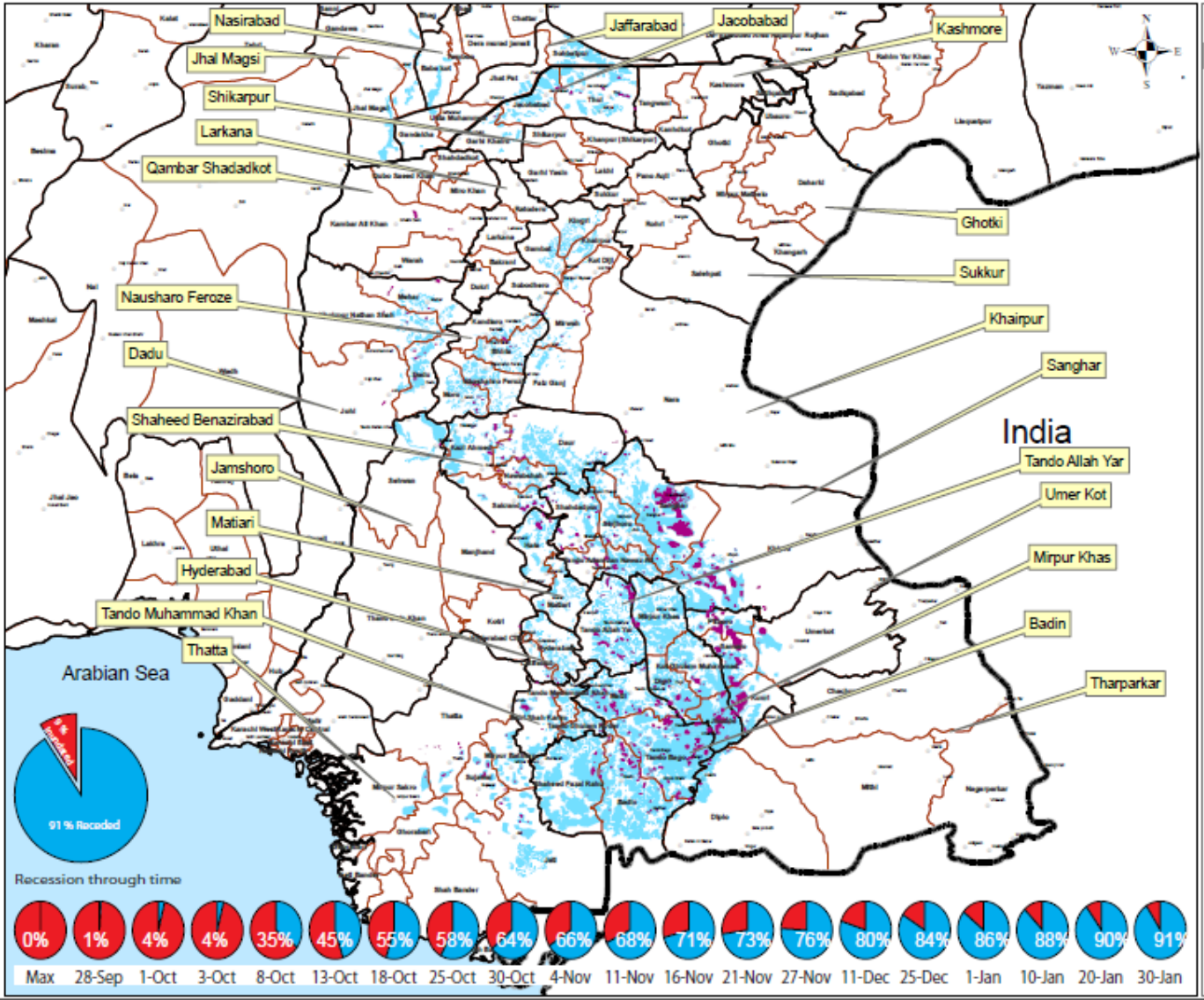




Timeline of Inundated area in sq.km

Max	28-Sep	1-Oct	3-Oct	8-Oct	13-Oct	18-Oct	25-Oct	30-Oct	4-Nov	11-Nov	16-Nov	21-Nov	27-Nov	11-Dec	25-Dec	1-Jan	10-Jan	20-Jan	30-Jan
0%	1%	4%	4%	35%	45%	55%	58%	64%	66%	68%	71%	73%	76%	80%	84%	86%	88%	90%	91%

Max Flood Extent against 30th January 2012 - Southern Pakistan



Legend

- International boundary
- Provincial boundary
- District boundary
- Tehsil boundary
- Major Towns
- Flood Extent February 30th 2012
- Max Flood Extent Sept 28th 2011

0 25 50 100 Kilometers

Data Sources
Administrative boundaries: GAUL
Data: SUPARCO
Dated: 30th January 2012
Creation date: 2nd February 2012
Code: FAOPK1065_Pakistan_Floods2011_Map_v07_20120202

Disclaimers:
The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Prepared by: Information Management Unit, FAO-ERCU, Pakistan

Summary

- FAO plays a critical role in national capacity development, as part of its mandate to assisting and empowering countries with knowledge, tools and methodology to undertake reliable assessments
- FAO fosters use of medium and high resolution EO observation agricultural monitoring and technology combined with in-situ observation to provide reliable information as decision support products
- FAO recognizes the need for adequate resourcing of the agricultural monitoring activities of member countries, to support sustainable agriculture development, addressing food security and climate variability

Links

- Trade and Markets Division (EST)
  - **GIEWS:** *http://www.fao.org/giews/english/index.htm*
- Statistics Division (ESS)
  - **FAOSTAT family:** *http://faostat.fao.org/default.aspx*
- Climate, Energy and Tenure Division (NRC)
  - **Climpag:** *http://www.fao.org/nr/climpag/*
- Land and Water Division (NRL)
  - **GAEZ;** *http://www.fao.org/nr/gaez/ (FAO internal only)*
  - **GLCN:** *http://www.glcn.org/*
  - **FAO GeoNetwork:** *http://www.fao.org/geonetwork/*

John S. Latham
Senior Land and Water Officer (NRL)

This presentation has been developed in collaboration with:
Trade and Markets Division (EST)
Statistics Division (ESS)
Climate, Energy and Tenure Division (NRC)