# Satellite Data for Risk and Security: Tools and Approaches


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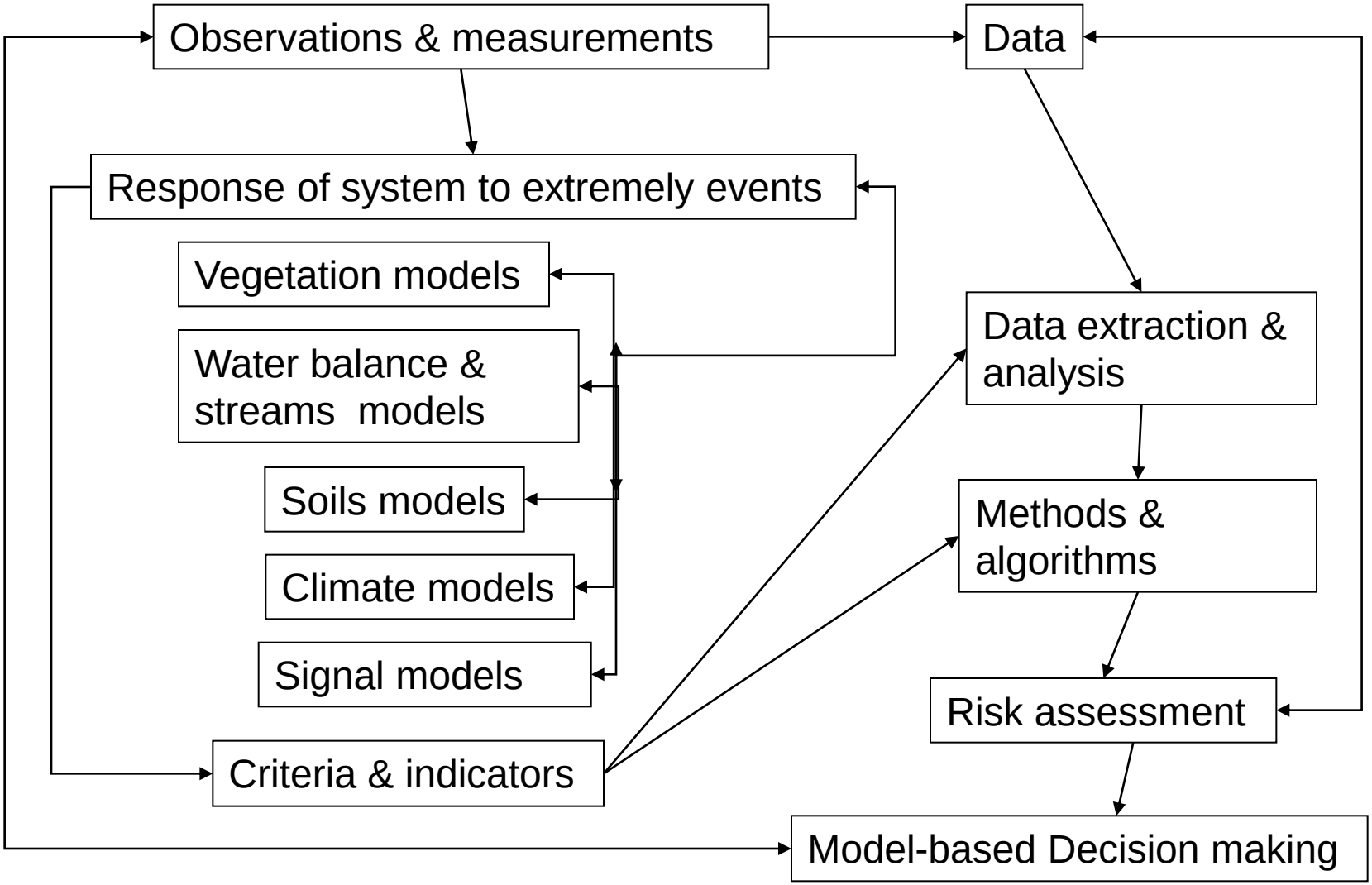
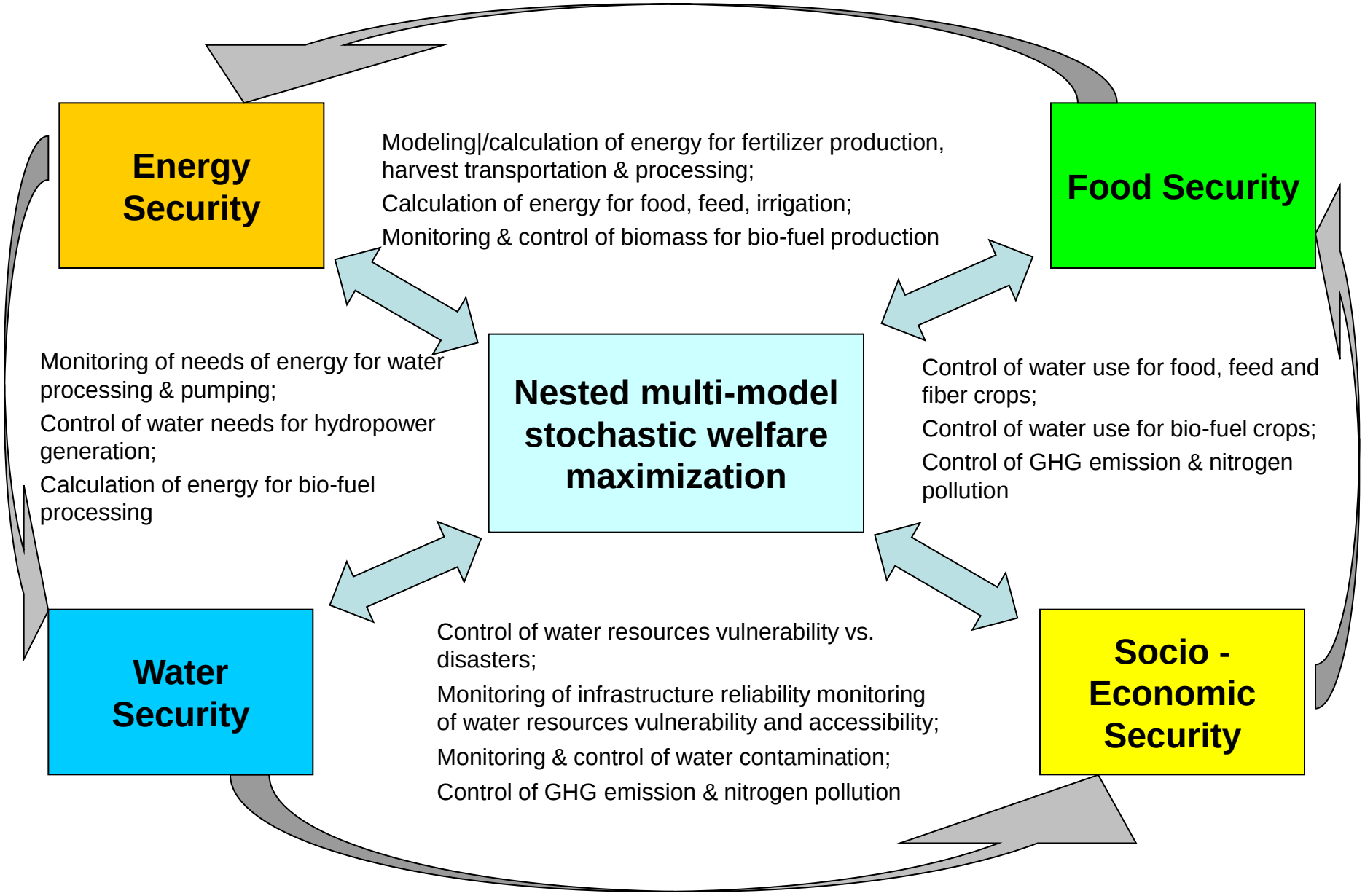
# Approach to Utilization of EO Tools for Risk Analysis

**Multi-model optimization and planning for setting of adaptive risk analysis**

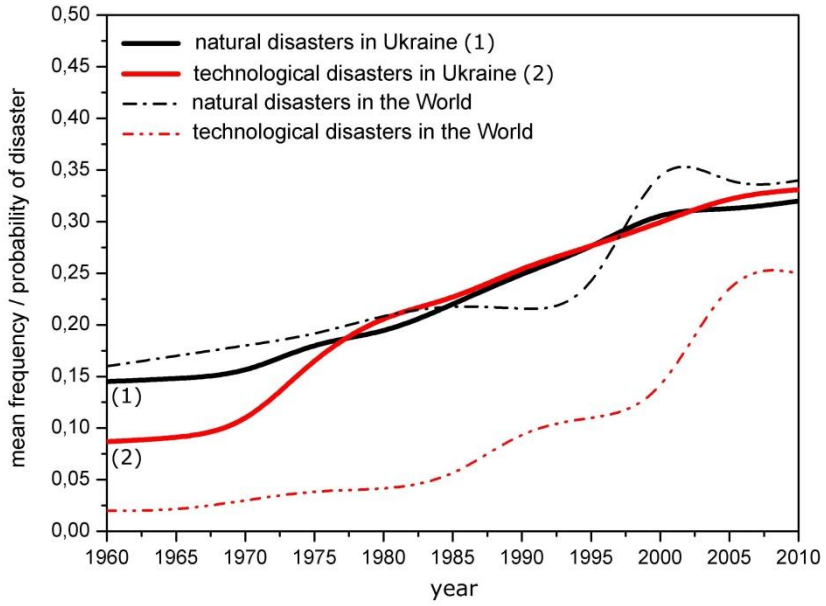


# Integrated Approach to Security Analysis

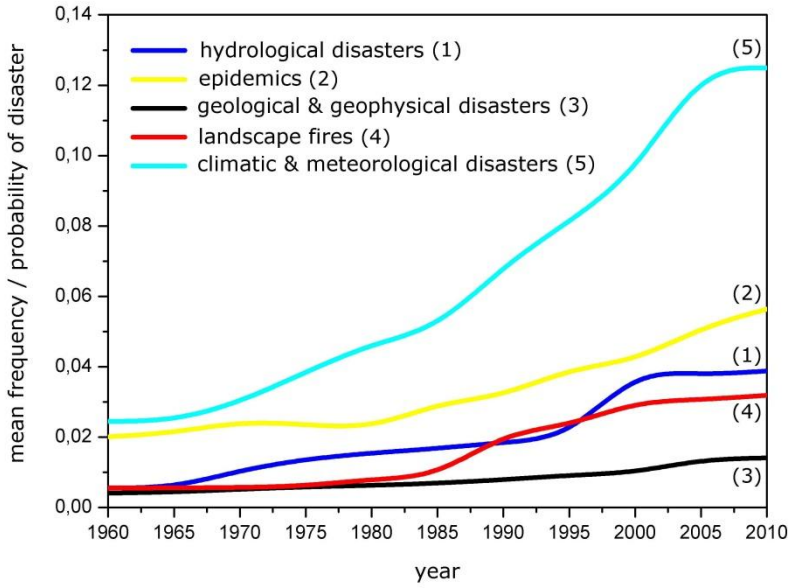


# Disaster Analysis & Decision Making

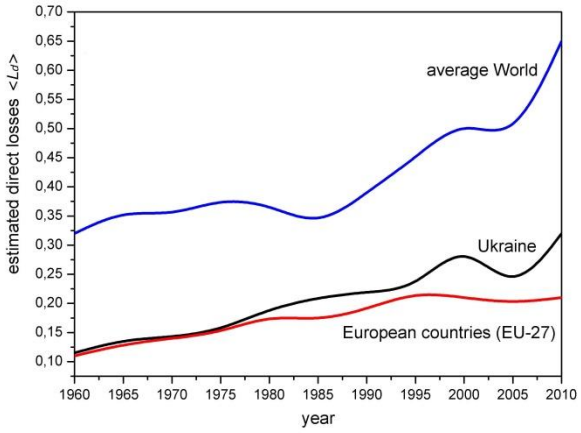
## Natural and technological disasters



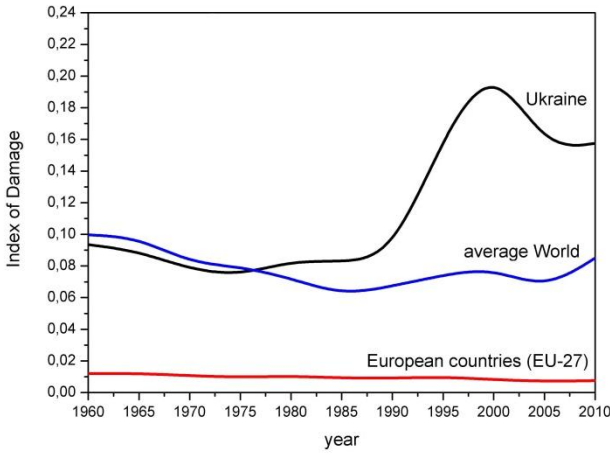

## Separate types of natural disasters



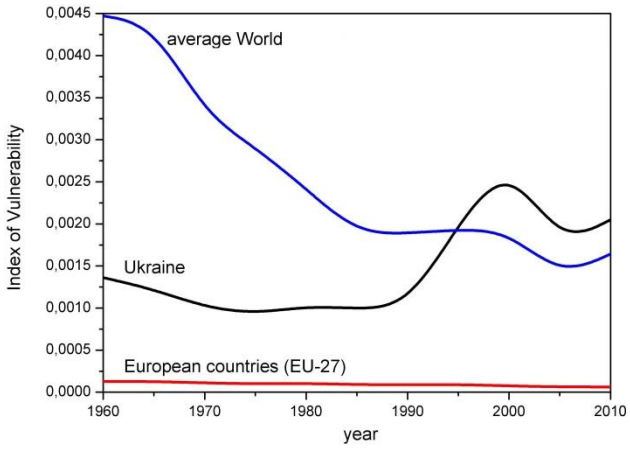

## Direct losses of natural disasters




## Losses per capita GDP

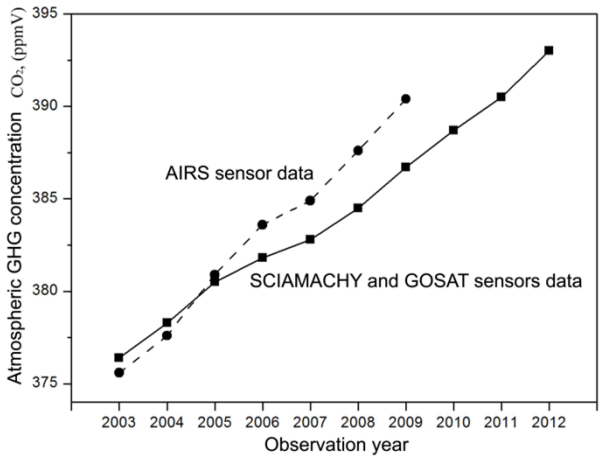



## Losses per capita GDP and population

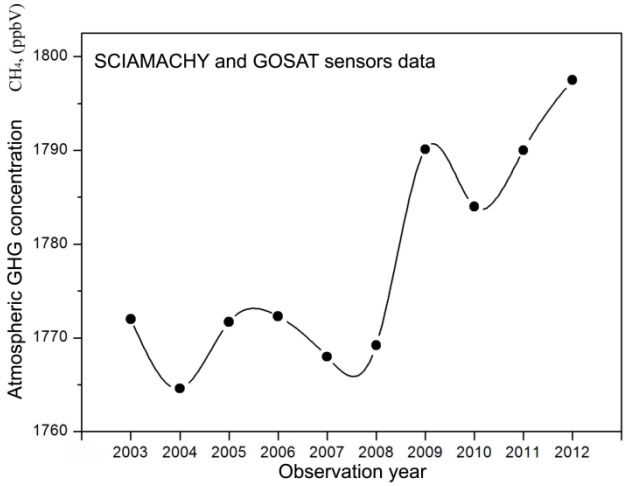


# GHG Emissions Satellite Control & Analysis

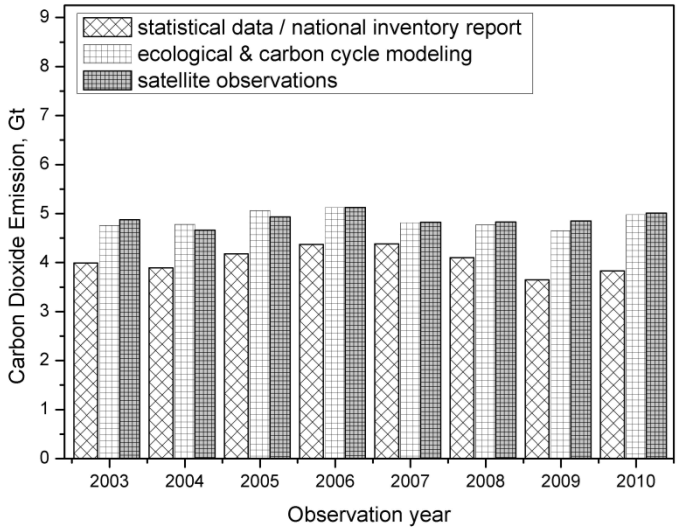
## Carbon dioxide concentration satellite detected dynamics



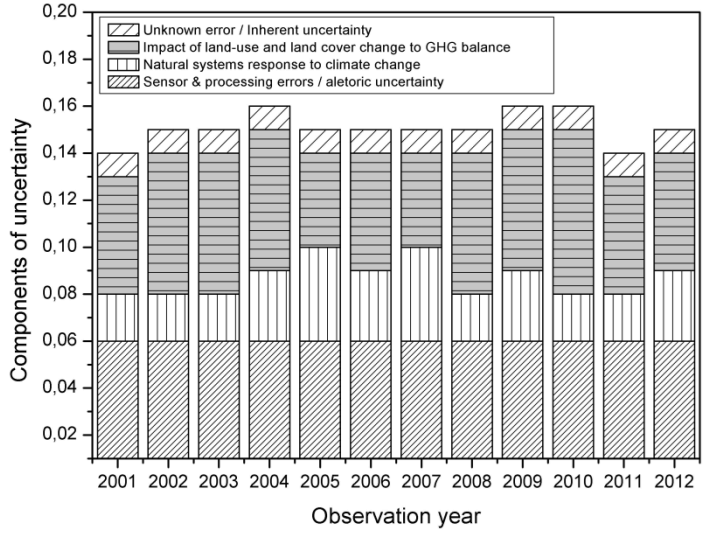

## Methane concentration satellite detected dynamics




## Comparison of emissions data from different sources

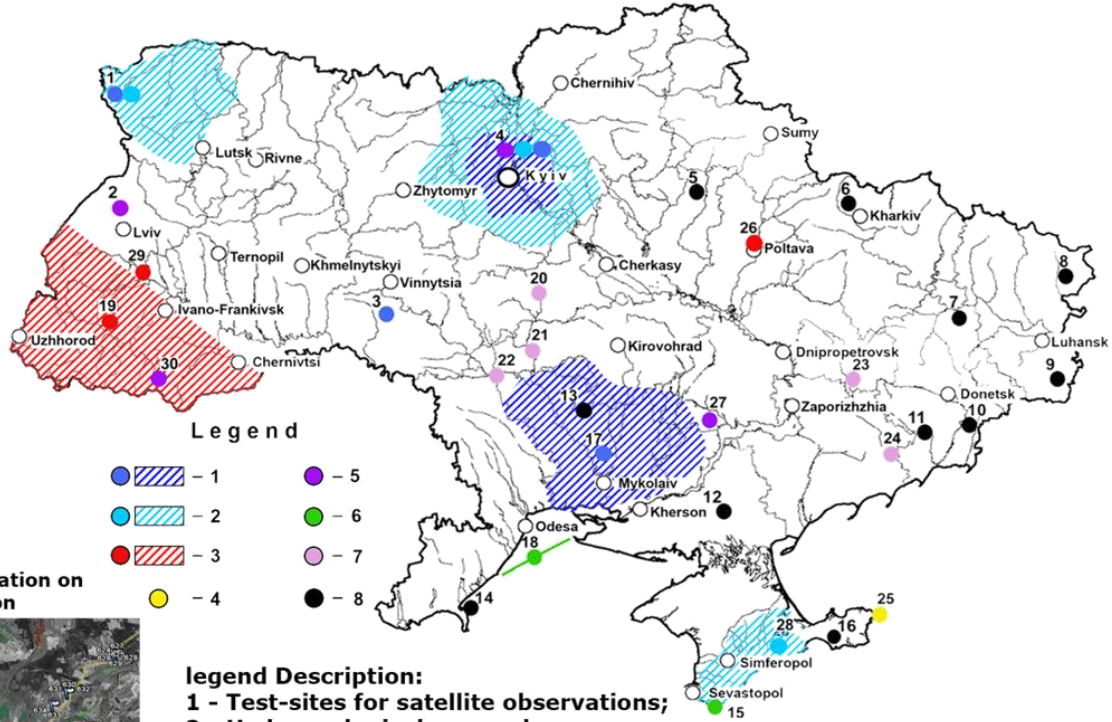



## Estimation of components of uncertainty of vegetation productivity detection using satellite data

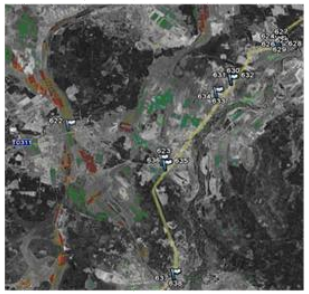


# Field test-site network for satellite and models calibration

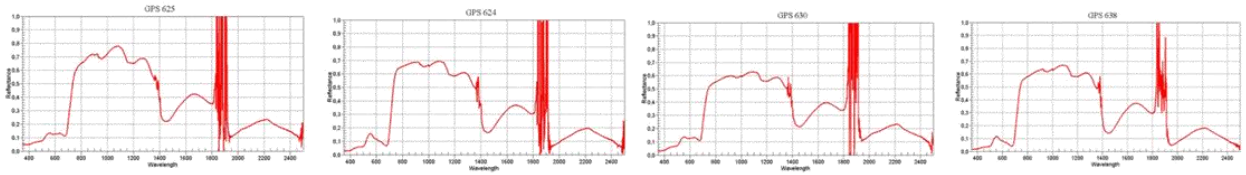
## In-Fields Research: Spectrometry by FieldSpec®3 FR for Crop Monitoring, Landscape Control & EO Calibration (data available since 2010)




Test-points location on Shatsky Polygon



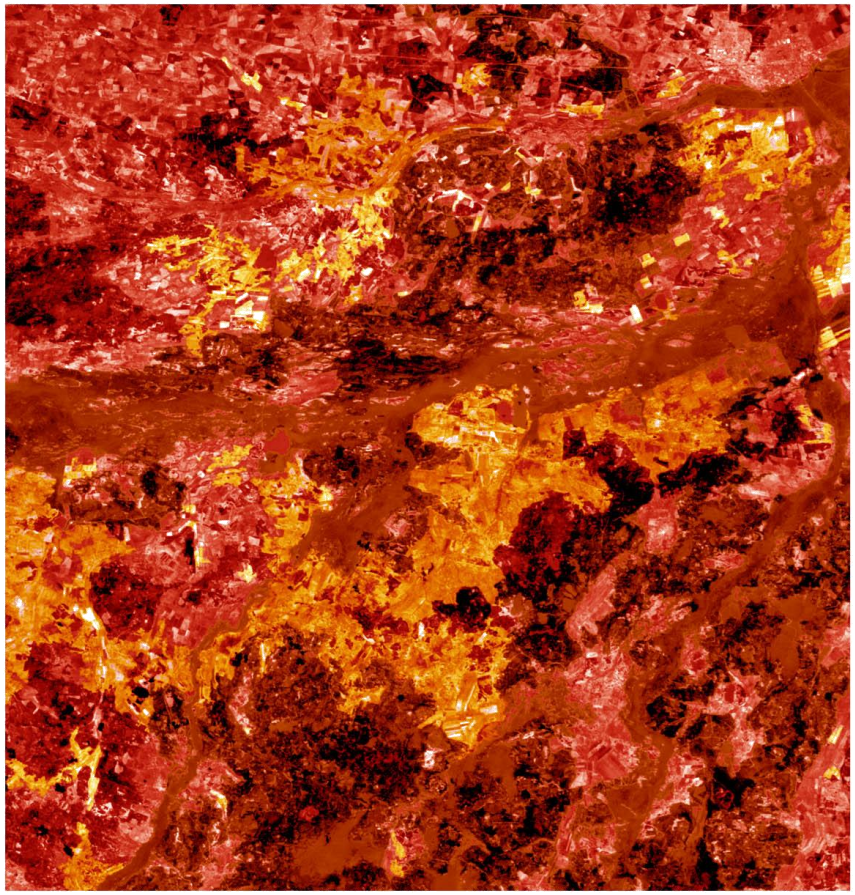
**legend Description:**
**1 - Test-sites for satellite observations;**
**2 - Hydrogeological research areas;**
**3 - Hydrochemical test-sites;**
**4 - Geophysical research areas;**
**5 - Geography research;**
**6 - Marine research;**
**7 - Ore studies;**
**8 - Multi-purposes test-sites**



# Case Study: Local Landscape Fire Risk Assessment

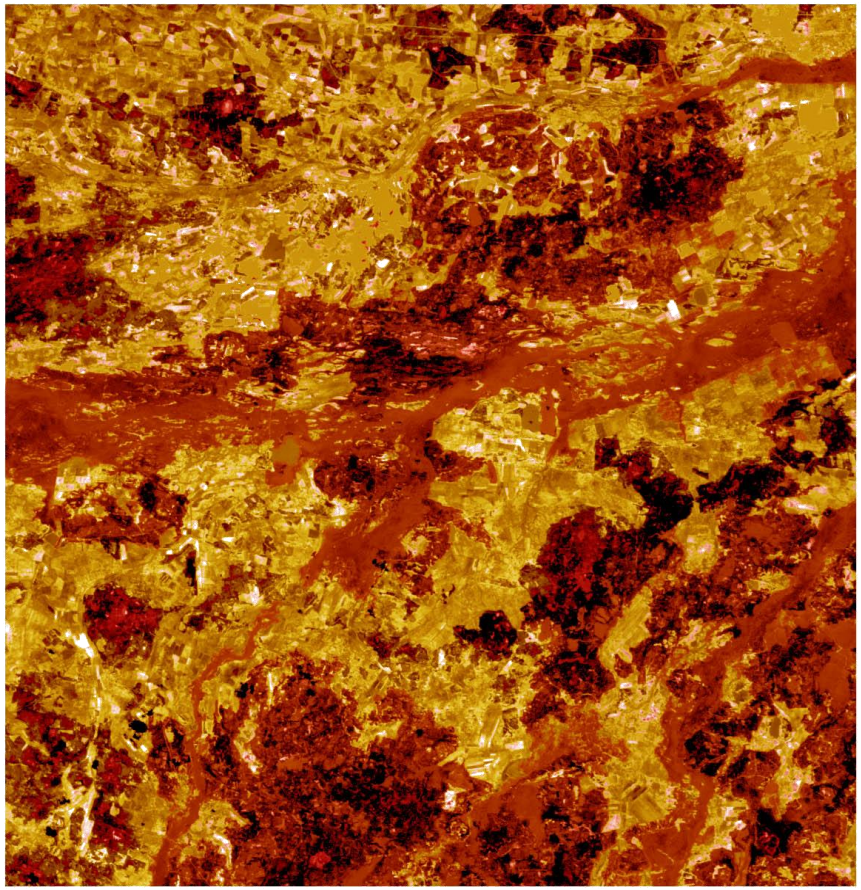
**Landscape fire risk calculated on 100m cell for Prypyat river middle basin (Northern-West part of Ukraine). Data used: Landsat TM& ETM data.**

July 15 – August 15, 2006: mean 0,38



0,05 integrated landscape fire risk 0,85

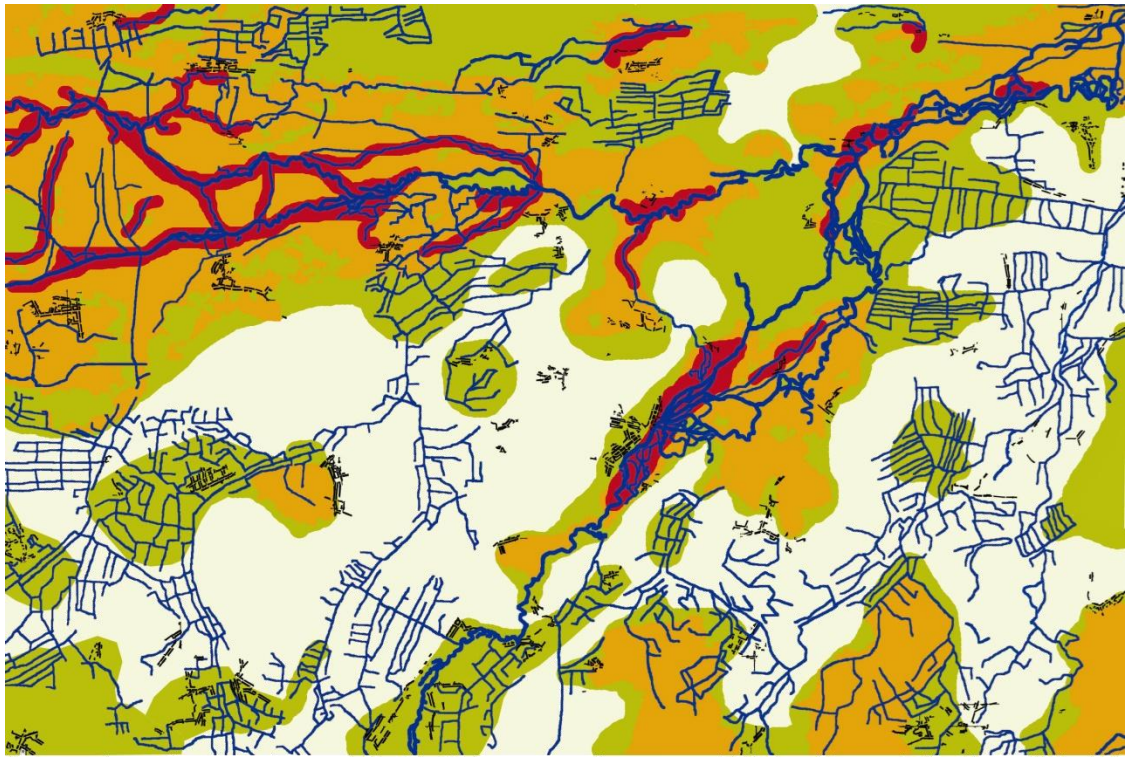
July 15 – August 15, 2007, mean 0,26



0,05 integrated landscape fire risk 0,85

# Regional and Local Flooding Risk Assessment

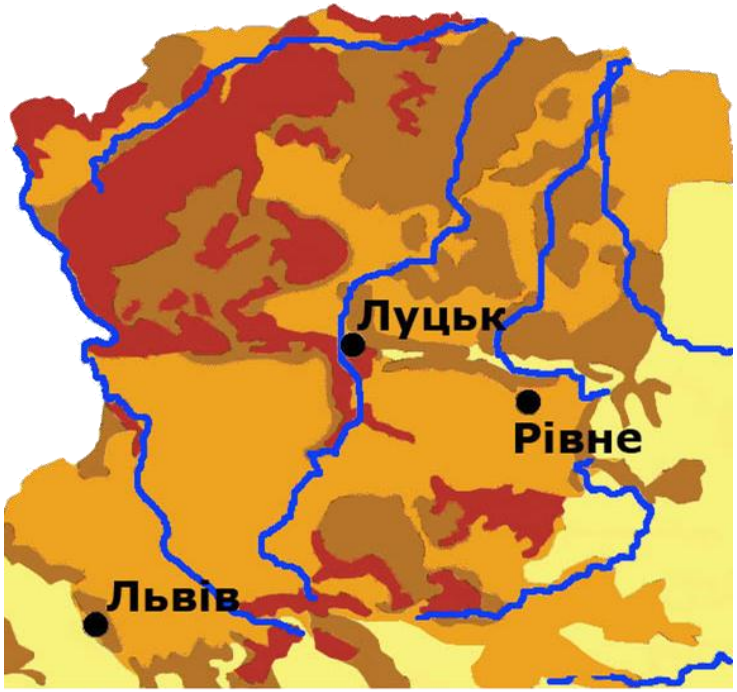
Local flooding risk calculated on 200m cell for Prypyat river middle basin (Northern-West part of Ukraine) for period March – June 2011. Data used: Landsat TM& ETM, MODIS.



>0,4 0,35 - 0,4 0,3 - 0,35 0,25 - 0,3

Risks assessed in terms of probability of negative consequences of flooding events for 1-year period. Value of risk ≥ 0,5 means that for certain exceeding of mean seasonal precipitation level (integrated exceeding of month norm more than to 50% i.e. from 95-100mm) or corresponding exceeding of mean runoff (from 0,2 $m^3$/sec $km^2$ reflected in exceeding of river water level to 1 – 1,8m) on the corresponding site will be fixed undeflooding (water table rising up to 0,3 – 0,8m). So value of risk ≥ 0,5 is means annual floods with probability 0,86 in view of registered climate trends.

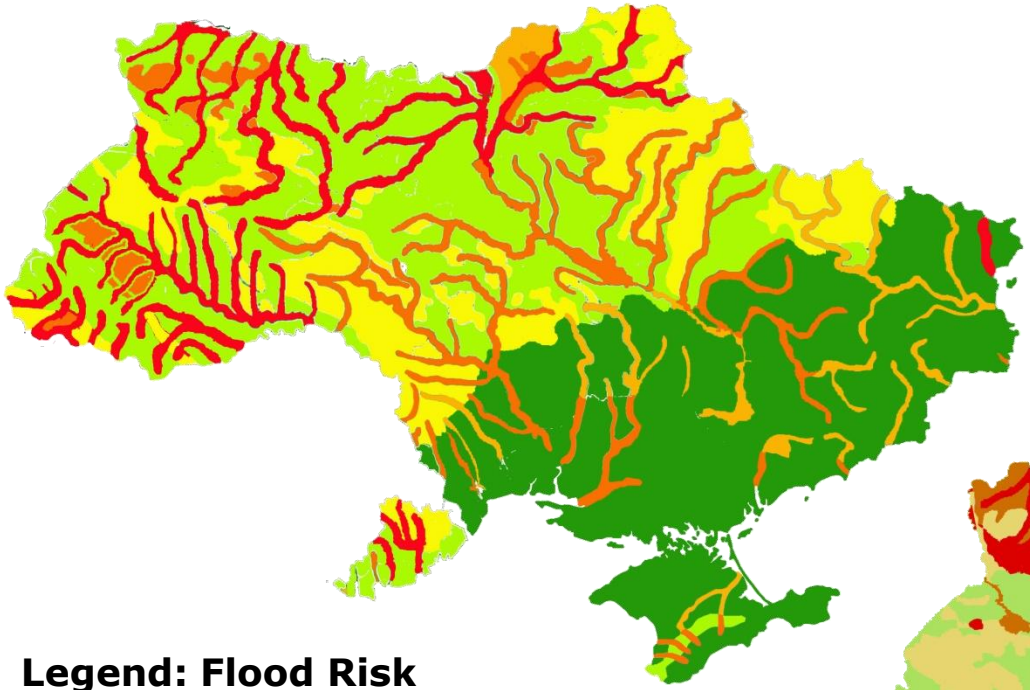
Regional flooding risk calculated on 5km cell for Northern-West part of Ukraine for period March – June 2011. Data used: Landsat TM& ETM, MODIS.



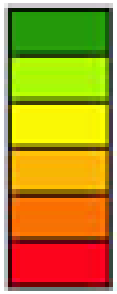

0,1 - 0,2
0,2 - 0,3
0,3 - 0,35
0,35 - 0,4

# Hydrological & Hydrogeological Disasters

## Flood Risks on 50km cell for 2025 - 2035

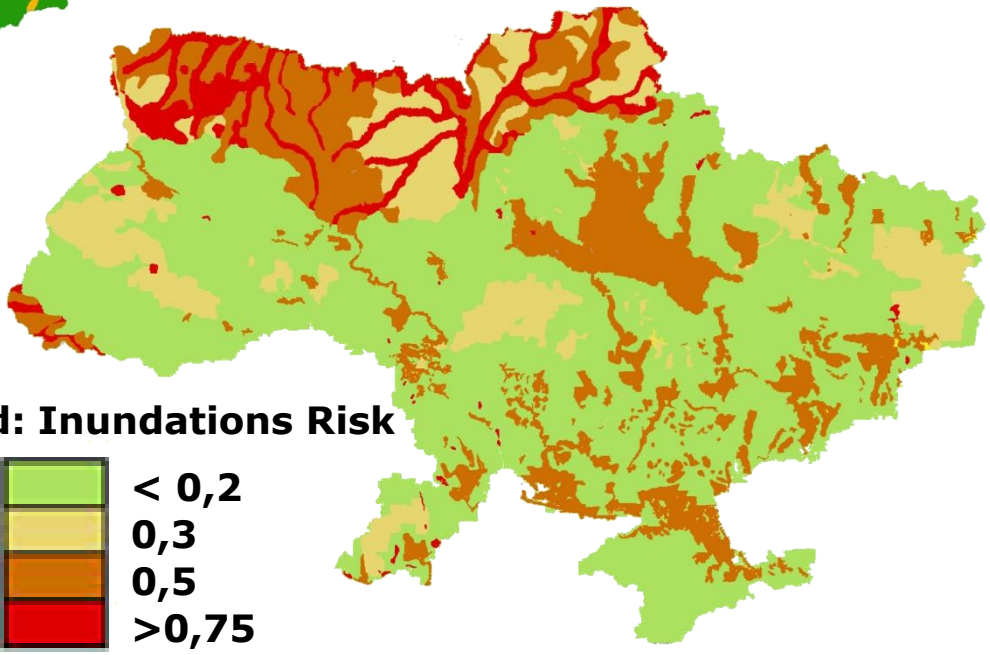


**Legend: Flood Risk**



< 0,2
0,3
0,4
0,5
0,6
>0,75

## Inundation Risks for 2025 - 2035

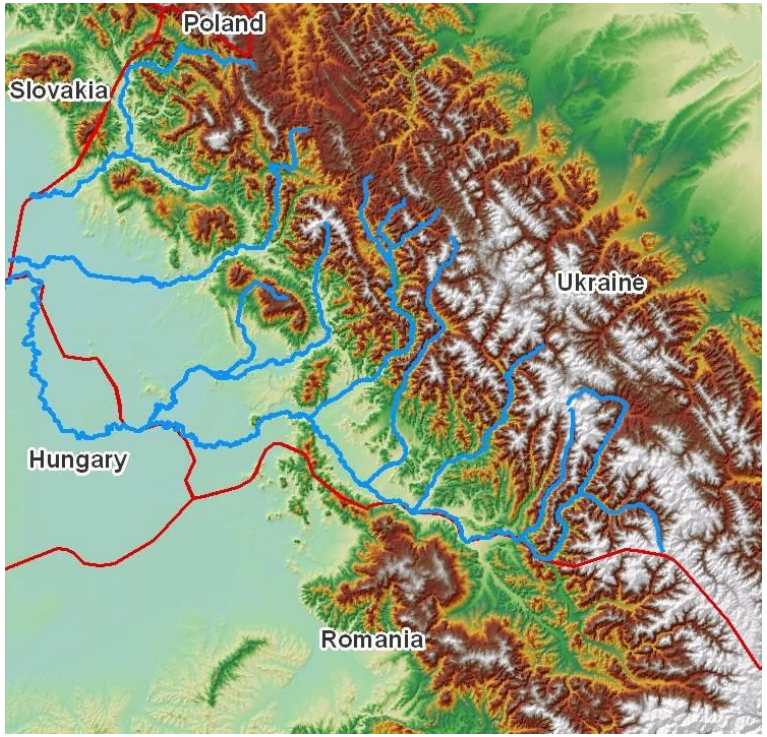


**Legend: Inundations Risk**

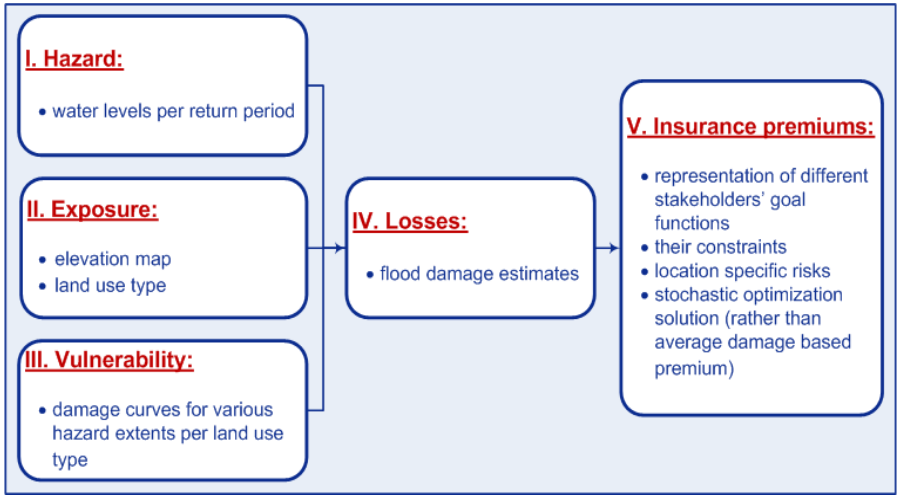


< 0,2
0,3
0,5
>0,75

# Case Study: Management of catastrophic floods in Tisza river basin



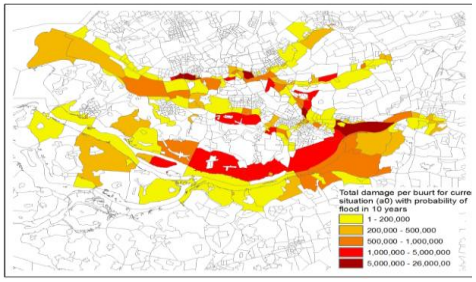

- Flood risks – model based approach
- Assessment of flood protection measures against multiple floods
  (structural, land use, financial)
- Efficiency of structural flood mitigation measures – Socio-economic impacts
  = *Influence on policy evaluation*
- Losses and loss reduction associated with certain flood events (heavy rainfall, dam break)



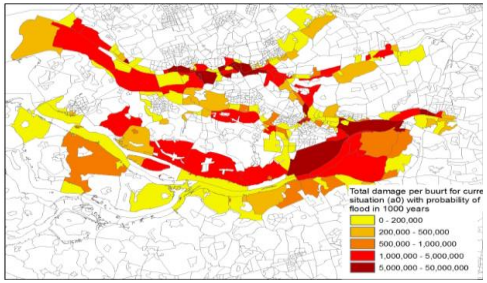
# Case Study: Disaster Analysis for Decision Making

Recent case study in the Netherlands (Risk Analysis Journal, 2016) on the analysis of alternative insurance mechanisms is also important for Ukraine as Ukraine develops alternative insurance mechanisms

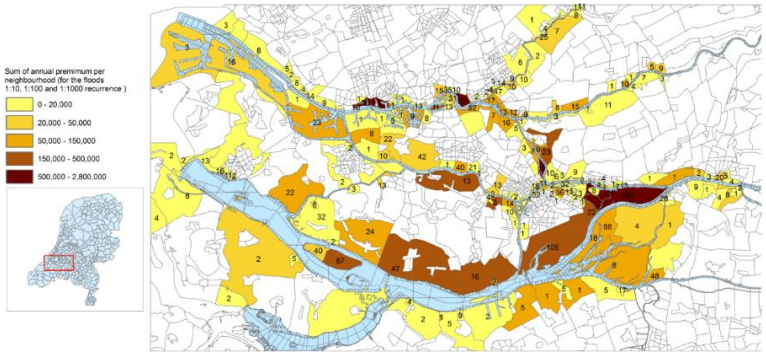

| Areas outside the main protections system | Protected areas within a dike-ring |
|---|---|
| *Flood and damage characteristics* | |
| Government does not guarantee any safety standards. Actual return periods vary between 1:5, 1:10 years to 1:100, 1:1000 years or less frequent (e.g. 1:10000 for new harbor areas) | Safety standards assigned by law:<br>1:200 to 1:1250 years – river floods<br>1:2000 and 1:4000 for the estuary (tidal rivers)<br>1:4000- to 1:10000 years – coastal floods. |
| Probability of flood is location-specific and may be much higher than the official safety standard in the neighboring protected areas. | One homogeneous safety standard for the whole dike-ring. |
| Properties are elevated above sea level, i.e. on dunes, man-made high elevation grounds, etc. | Many developments inside dike rings are below sea level (up to -6 meters). |
| Flood water comes with low velocity and goes away quickly. | Flood water comes with high velocity and stays for a long period. |
| *Flood protection and roles of different parties* | |
| Developments are at the risk on individuals (households or firms). Municipalities may prohibit some socially-vital activities in these areas, e.g. hospitals. | Government is responsible to assure safety standards prescribed by law. |
| Individuals are responsible for their own protection and damage in the case of flooding. | Government refund any possible damage from a flood event. |
| Flood insurance does not exist but is argued to be financially feasible [44]. | Until recently flood insurance did not exist. First contracts to insure flood risks became available in 2013 [3]. The issue is debatable since some consider it unfeasible [30], [32] while others think it is feasible under various reinsurance schemes [1]. |



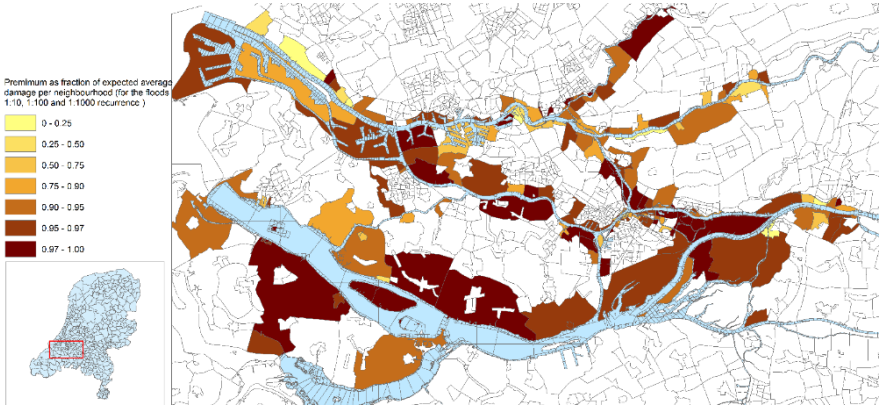

Losses, 10-yr. flood




Losses, 1000-yr. flood



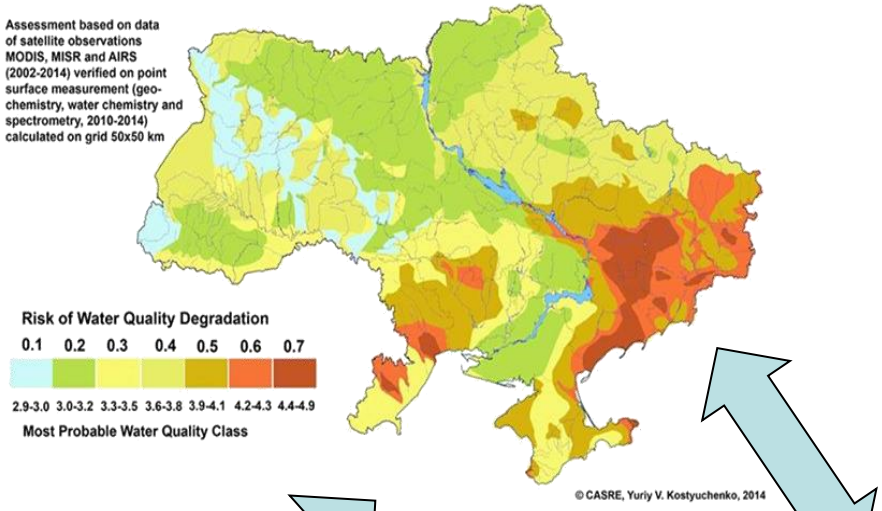

Robust annual premiums



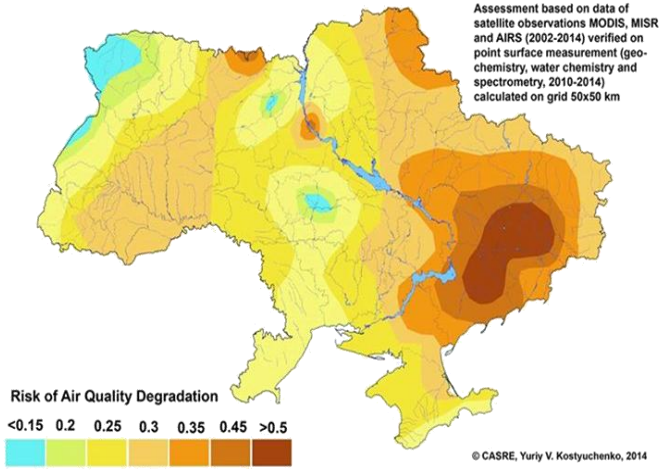

Premiums as percent of the 100-year flood damages

# Water, Air & Soil Quality degradation Risk Assessment

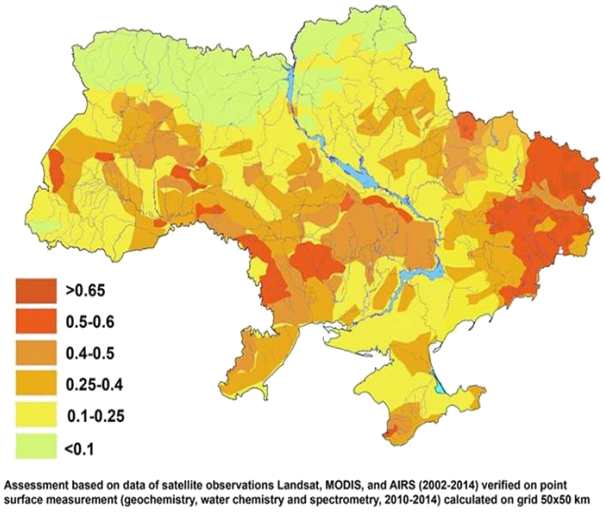
## Water quality degradation risk calculated on 50km cell using satellite data




## Air quality degradation risk

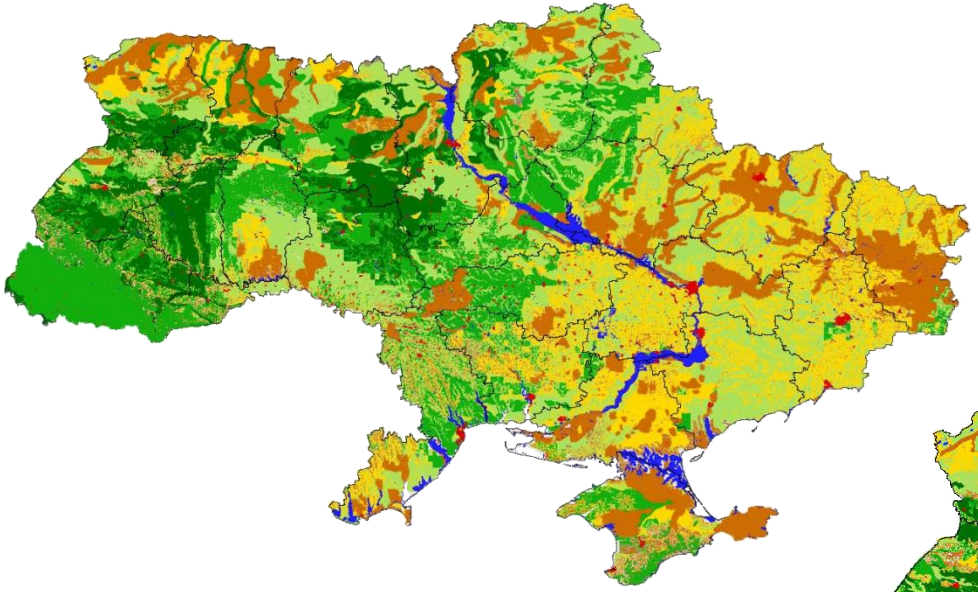



## Soil quality degradation risk

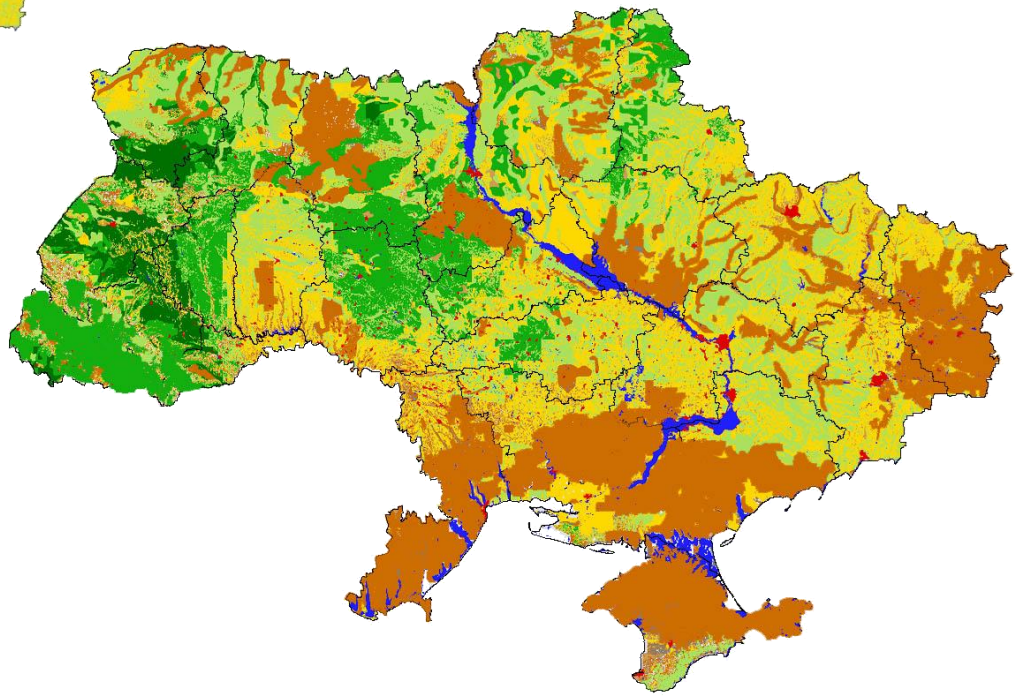


# Bioproductivity Degradation Risk

## Projected year 2025



## Projected year 2050



**Legend: Risk of Bio-productivity Losses on 50km cell**

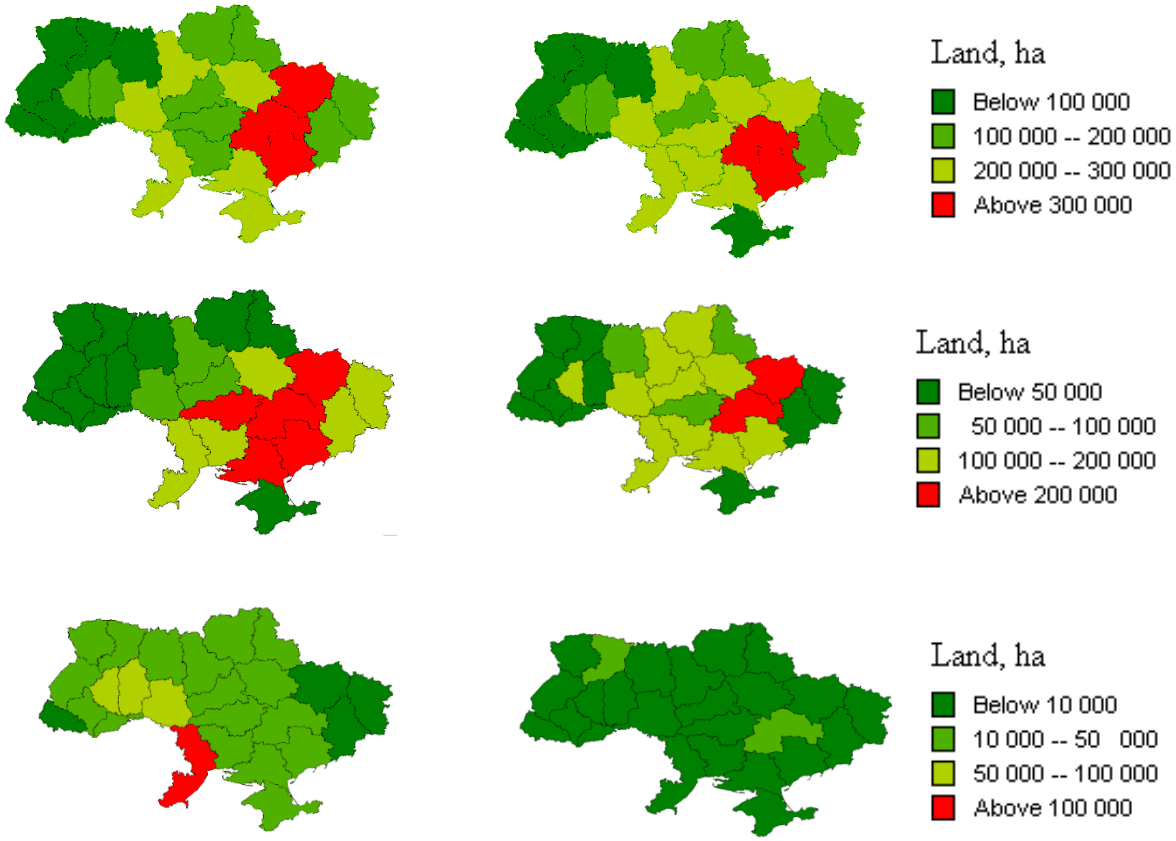
- < 0,25
- 0,3
- 0,5
- 0,6
- >0,7
- Build-up Sites
- Surface Water Bodies

# Robust Agricultural Productivity and Risk Analysis

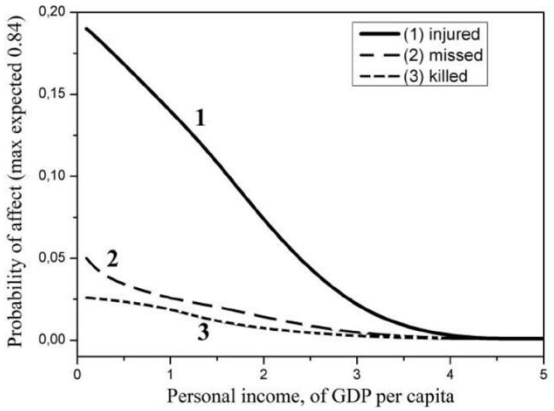
Analysis of optimal agricultural productivity using EO data toward climate change

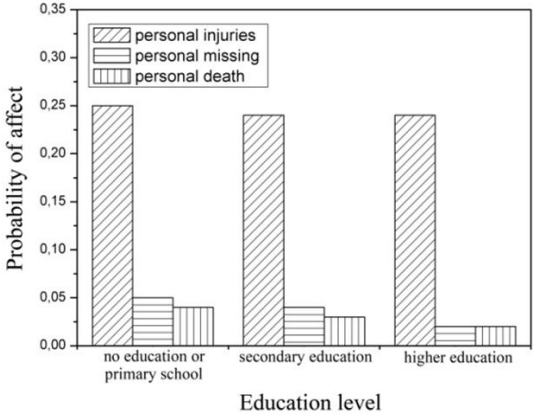
current

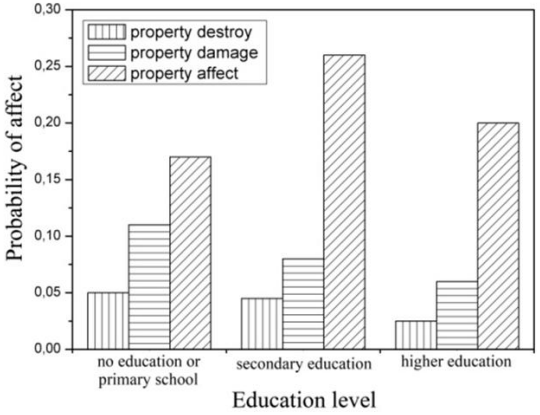
optimal

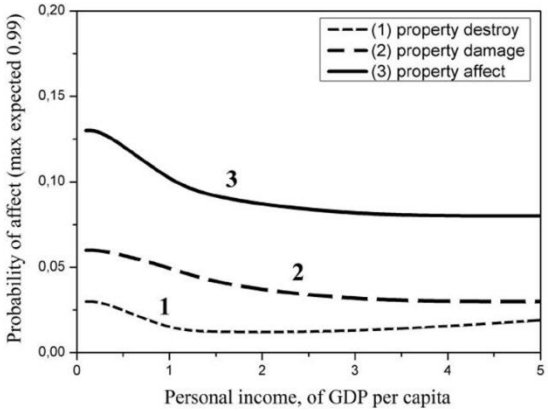


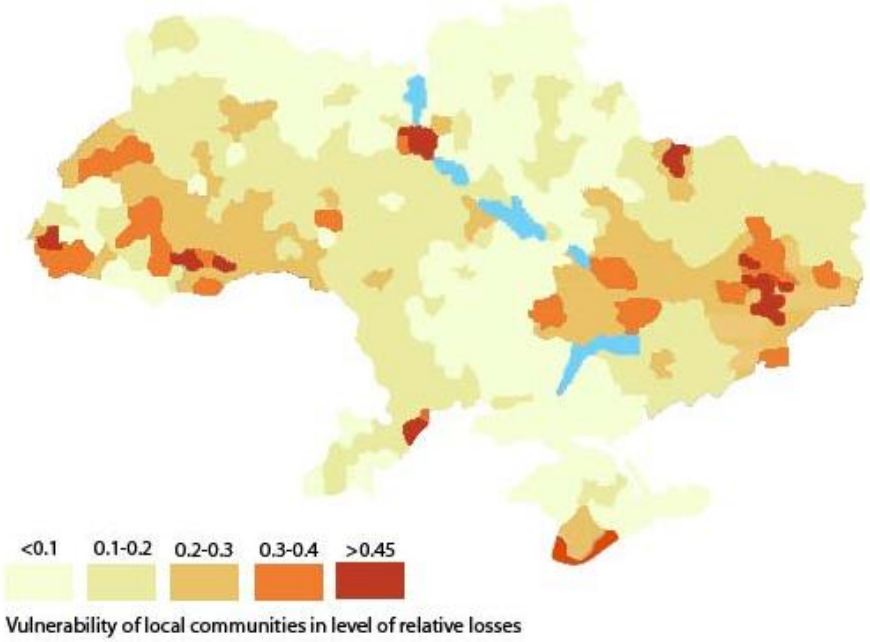
# Losses Distribution & Vulnerability Assessment



# Problem Areas, Gaps & Needs

**Water Resources**: assessment of availability, accessibility and vulnerability of surface and ground waters – for agriculture, energy, and support of quality of environmental services;

**Vegetation & Climate**: Multiparametric control of vegetation productivity in changing environment – for agriculture, ecology, food security, and energy;

**Disasters & Climate**: Catastrophic risk management tools – systemic risk analysis in view of local and regional climate and environmental change;

**Land use analysis** tools – for risk analysis & management in changing environment on regional and local scale.





# Thank you for all your courtesies

*Sincerely,*
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