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# Socio-economic Assessment of the rural Vulnerability of water users under stressors of global changes in Hard rock semi-arid area of south India

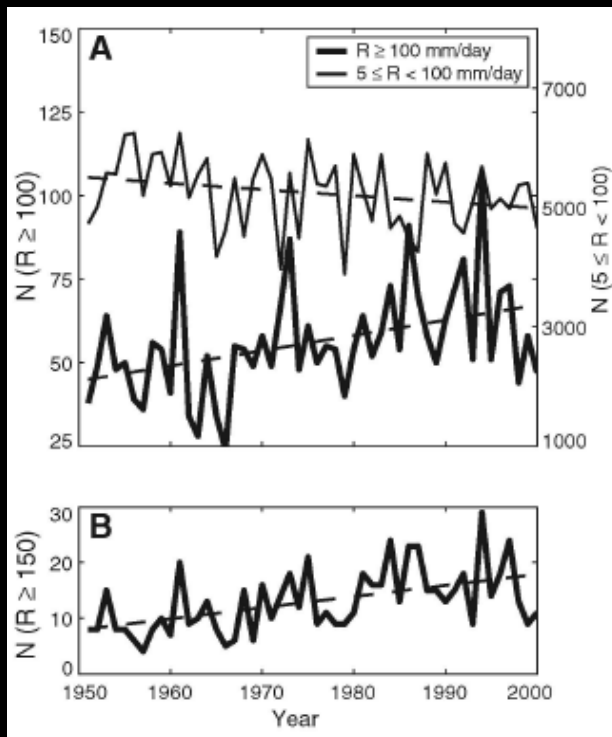
## The **SHIVA ANR-Project**

Aulong S., Borne F., Caballero Y., Chaudhuri B., Dazin F., Dewandel B., Dinis L., Galab S., Guerrin J., Himanshu, Ladouche B., Maire E., Maréchal JC., Muthusankar G., Perrin J., Prudhvikar Reddy P., Ramesh BR., Sannier, C., Sekhar M., Shakeel A., Vigaud N.

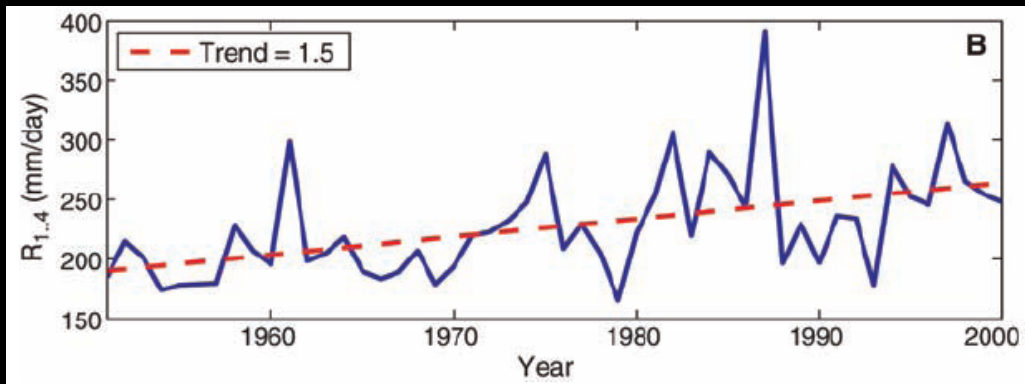
2010 International Conference in Integrative Landscape Modelling  
Montpellier, 3-5 February 2010



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- Decrease of number of moderate daily rain events.
- Increase of number of heavy and extreme daily rain events.
- Increase of the mean rainfall of the four highest rain events every season.



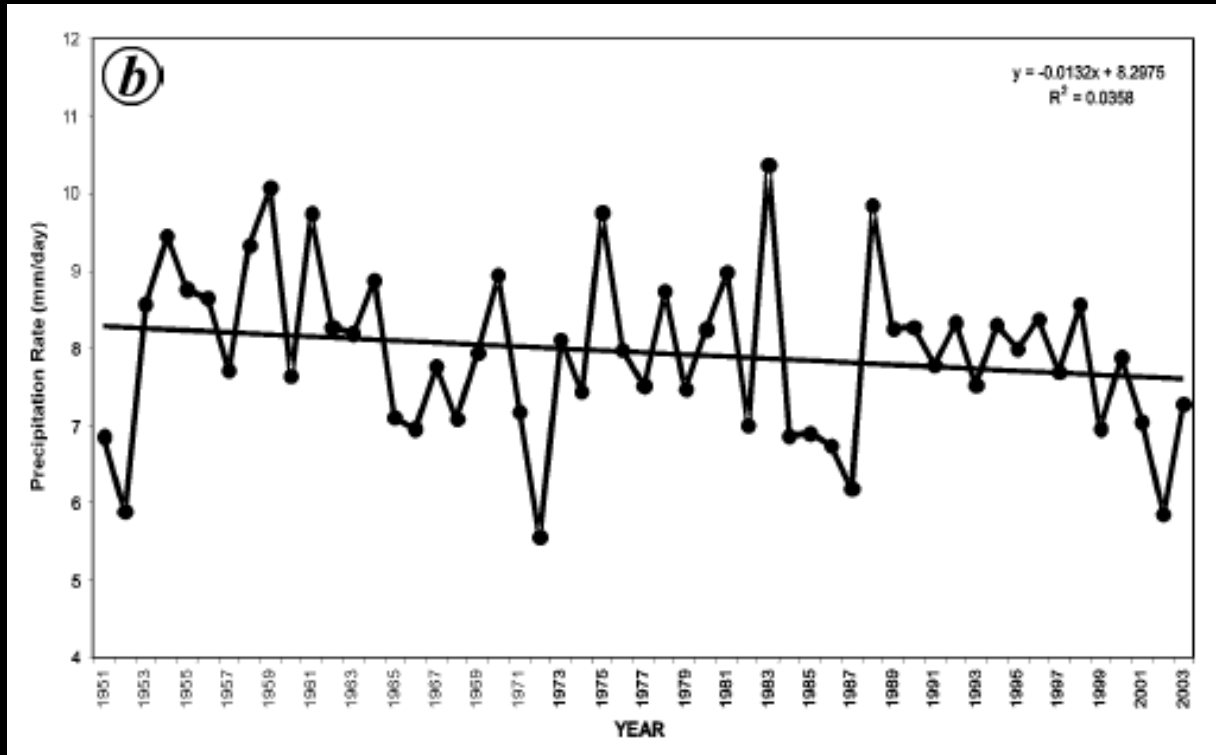
From Goswami et al. 2006. SCIENCE, 1442



# Climate change in India



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IMD gridded rainfall analysis. Decrease of precipitation rate during monsoon season (Jun-Sept) over 1951-2000 period

From Rajeevan et al. 2006. CURRENT SCIENCE, VOL. 91, NO. 3



# Agricultural changes



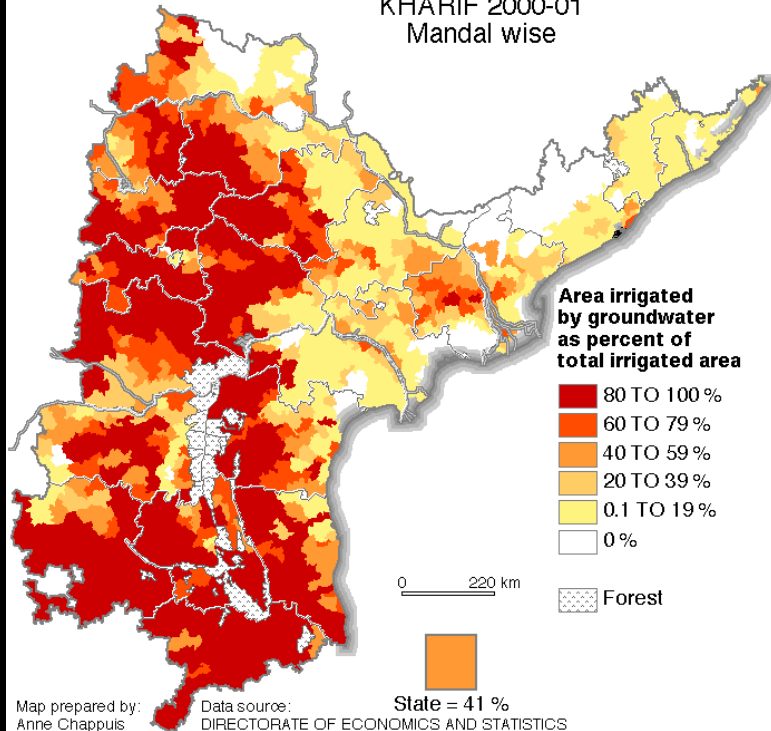
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- AP: Agrarian crisis  $\Leftrightarrow$  increase of farmers' suicides
- Most of problems rely on credit and debt:
  - 49% of farmers households are indebted in India. 82% in AP, 62% in K. (Mahendra Dev, 2006)
  - Increasing inclusion of credit within marginal and small farmers' classes. Credits are 80% informal with crucial dependence to money lenders
- Other changes: lack of water & drying up of groundwater; lack of remunerative prices; lack of alternative activities in rural areas

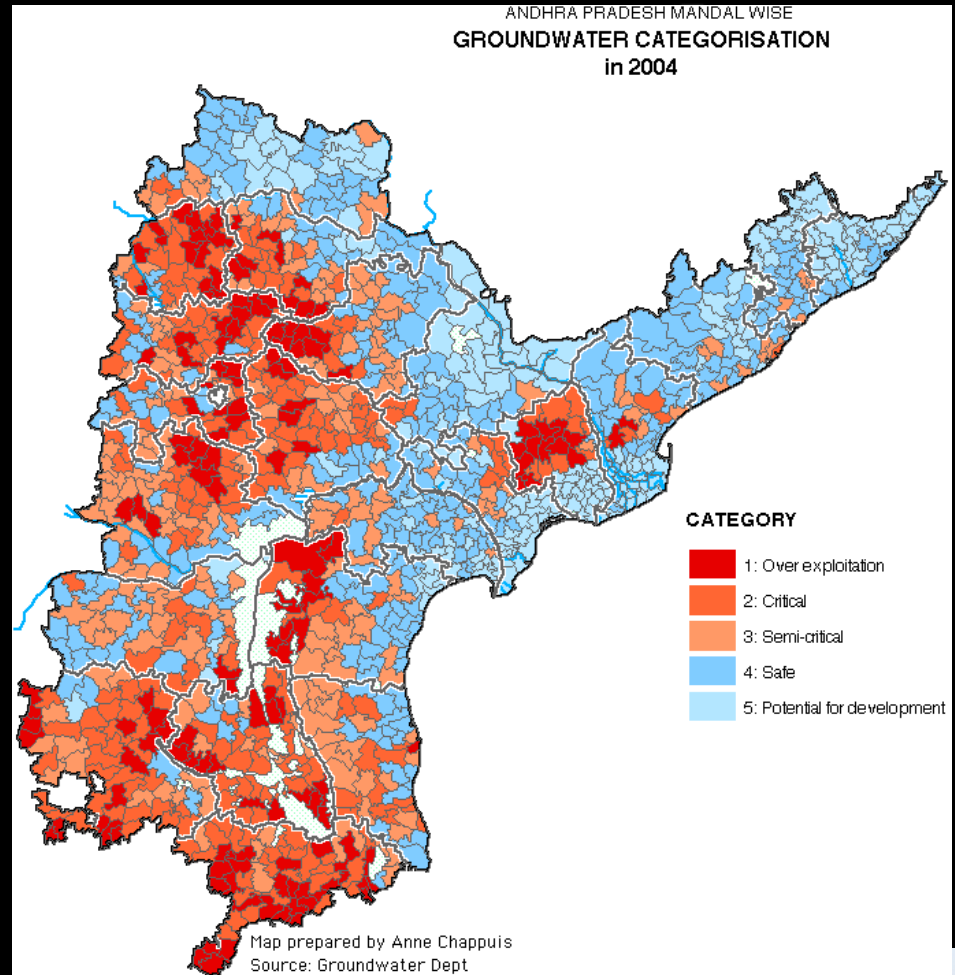


**IRRIGATION SOURCE: GROUNDWATER**  
**KHARIF 2000-01**  
**Mandal wise**



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**ANDHRA PRADESH MANDAL WISE**  
**GROUNDWATER CATEGORISATION**  
**in 2004**



# Objectives of SHIVA project



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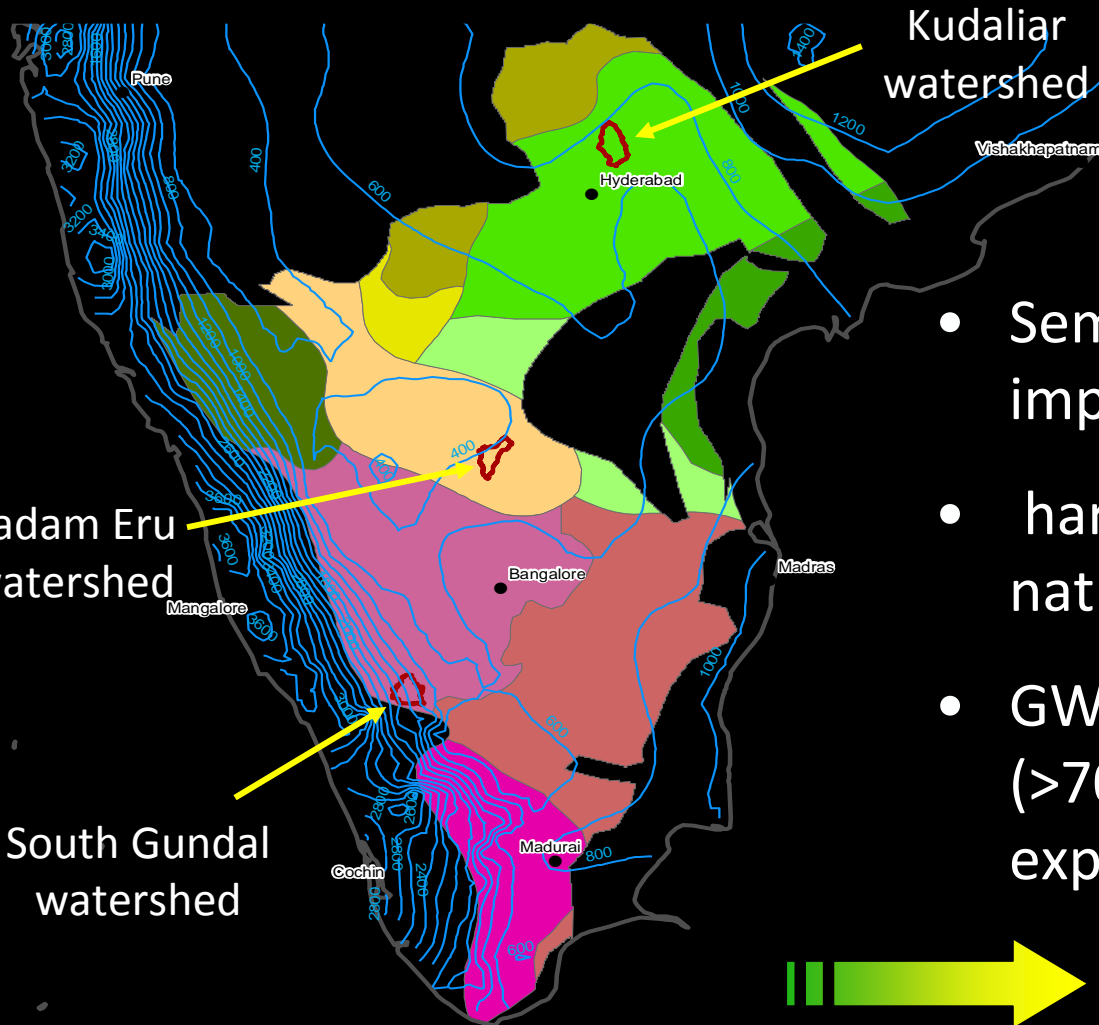
- To estimate the vulnerability of farmers to both climate and human changes by 2030 and 2050
- To assess the impacts of vulnerability in terms of costs and benefits
- To evaluate the possibilities to modify rural vulnerability trends through adapted water management policies or initiatives



# METHOD (1)



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- Semi- arid climate already impacted by climate change
- hard rocks geology with naturally limited GW resources
- GW is the main water resource (>70%) with large over-exploited areas

**Area and pilot sites definition**



# METHOD (2)



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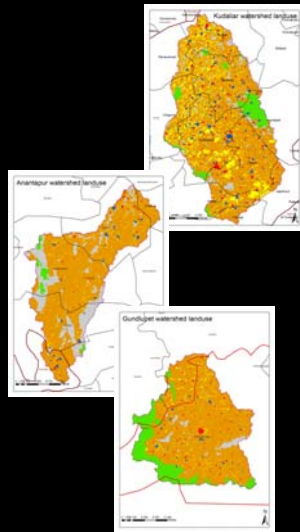
Present farmers' vulnerability

2010



2030 - 2050

Future farmers' vulnerability, impact assessment & policy & measures guidelines



Climate change regional scenario

Human change regional scenario

ETP, recharge

Water uses

Urbanization  
Farming patterns



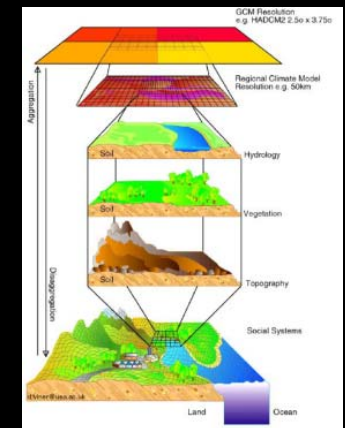
# Preliminary results (1)



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- Climate change scenario downscaling
  - Rainfall and temperature data collection
  - Choice of 5 GCMs identified as most 'reliable' regarding southern India climate
  - After validation on historical statistical characteristics (1980-1999), the CDF-t method is applied on deseasonalized data anomalies with an historical calibration period (ex 1961-1999).



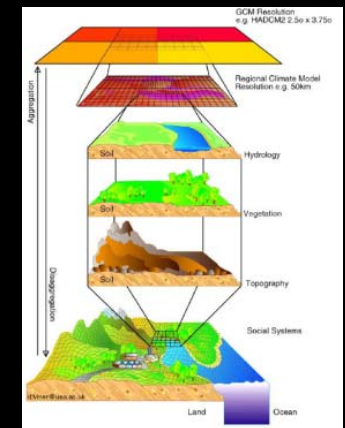
# Preliminary results (1)



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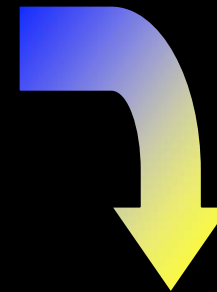
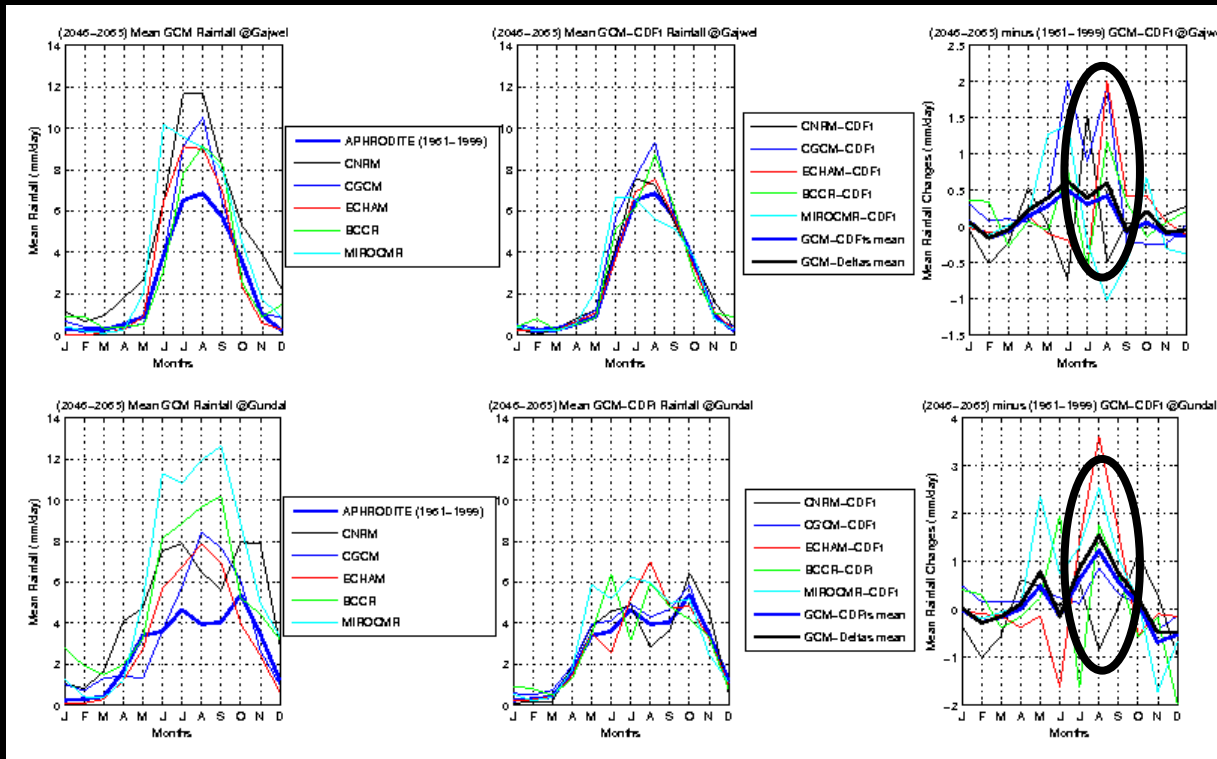


- The projected signal is reconstructed using the future large-scale seasonal cycle where the historical biases have been removed (period 2046-2065)
- CDF-t results are compared to output from a standard correction procedure applied to raw GCM data, the Delta method (Déqué, 2007)



# Preliminary results (1)

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Both correction methods show an increase in precipitated amount from June to September, particularly pronounced for the southern Gundal basin during the second half of the monsoon season

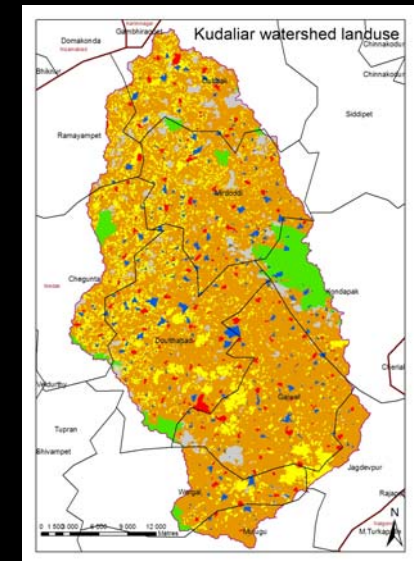
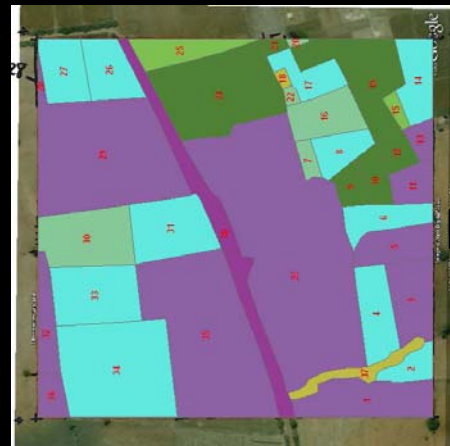


# Preliminary results (2)



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- Land cover and land use
  - Satellite images acquisition
  - Field work to interpret land cover and land use
  - Land cover and land use classification
  - Regression estimator to calculate land cover and land use over the 3 pilot sites



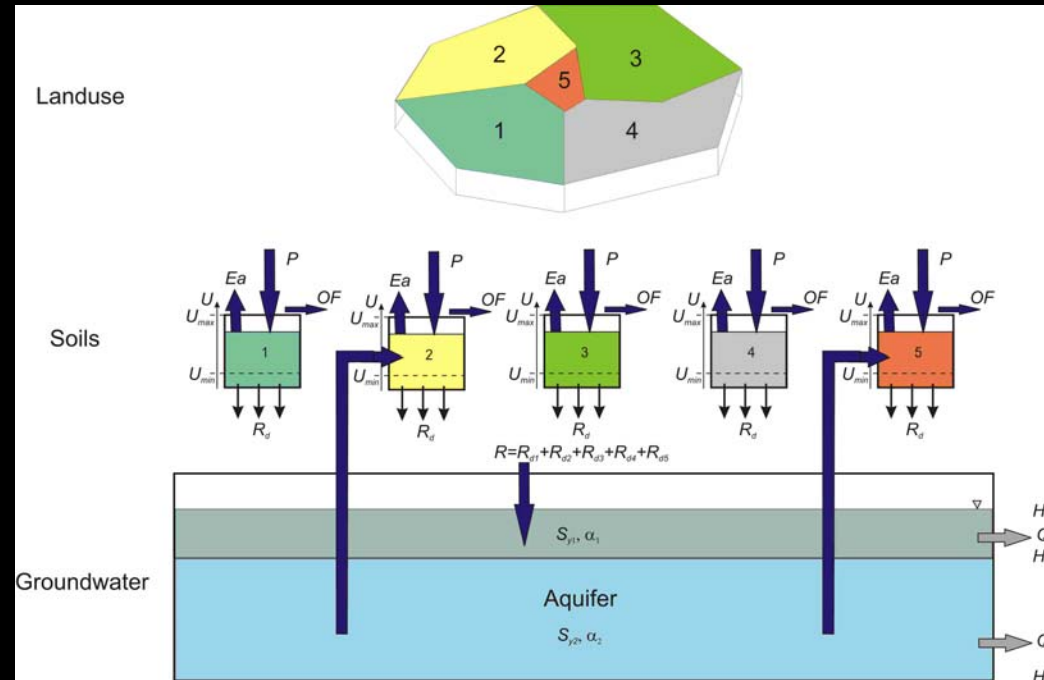
# Preliminary results (3)



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- Hydrological modeling:
- To assess the water resource
- Use of SWAT model integrating plant growth and ETP, soil and aquifer. SWAT is based on aggregated homogeneous units (climate, landcover, soil).
- Calibration based on piezometric data



# Preliminary results (4)



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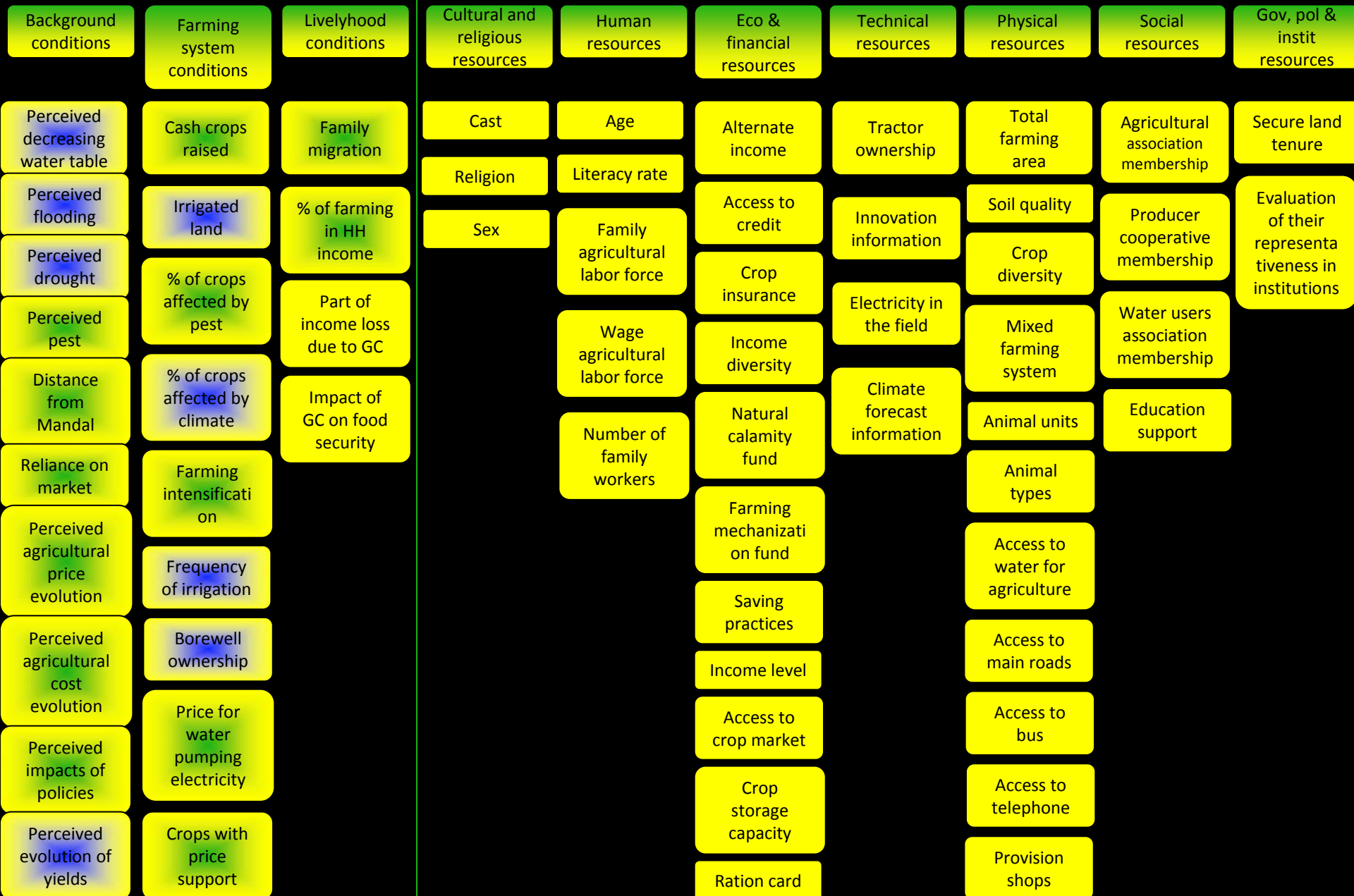
- Farmers' vulnerability assessment (reference state)
  - Vulnerability index:  $V = f(s; ac)$   
where  $s$  is sensitivity of farmers to GC and  $ac$  is their adaptive capacity
  - Method to calculate the index is based on analytic hierarchy process and fuzzy logic (Eakin et al. 2008)
  - Experts' judgment to weight indicators. Experts' profiles to give a sensitivity analysis of vulnerability scores



# Vulnerability

## Sensitivity

## Adaptive capacity

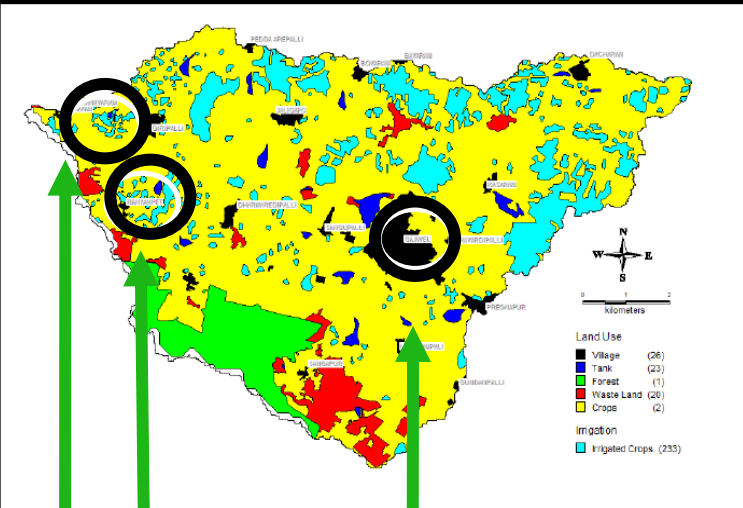


# Preliminary results (4)



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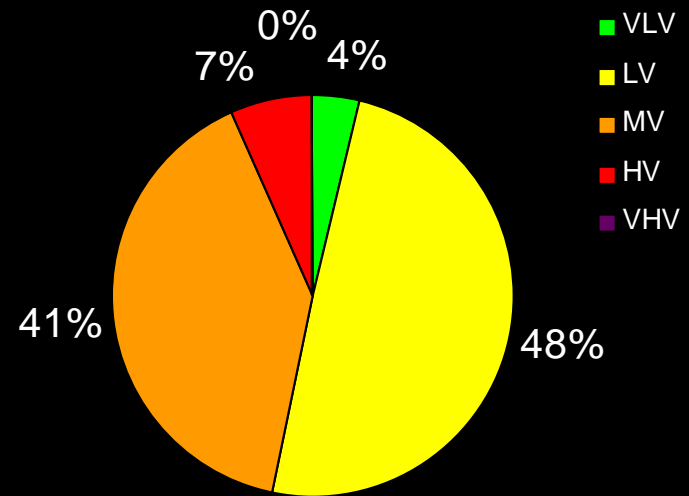
Method tested in a small watershed of 80 km<sup>2</sup> belonging to one of the 3 pilot sites.



Gajwell village

Rangampet village

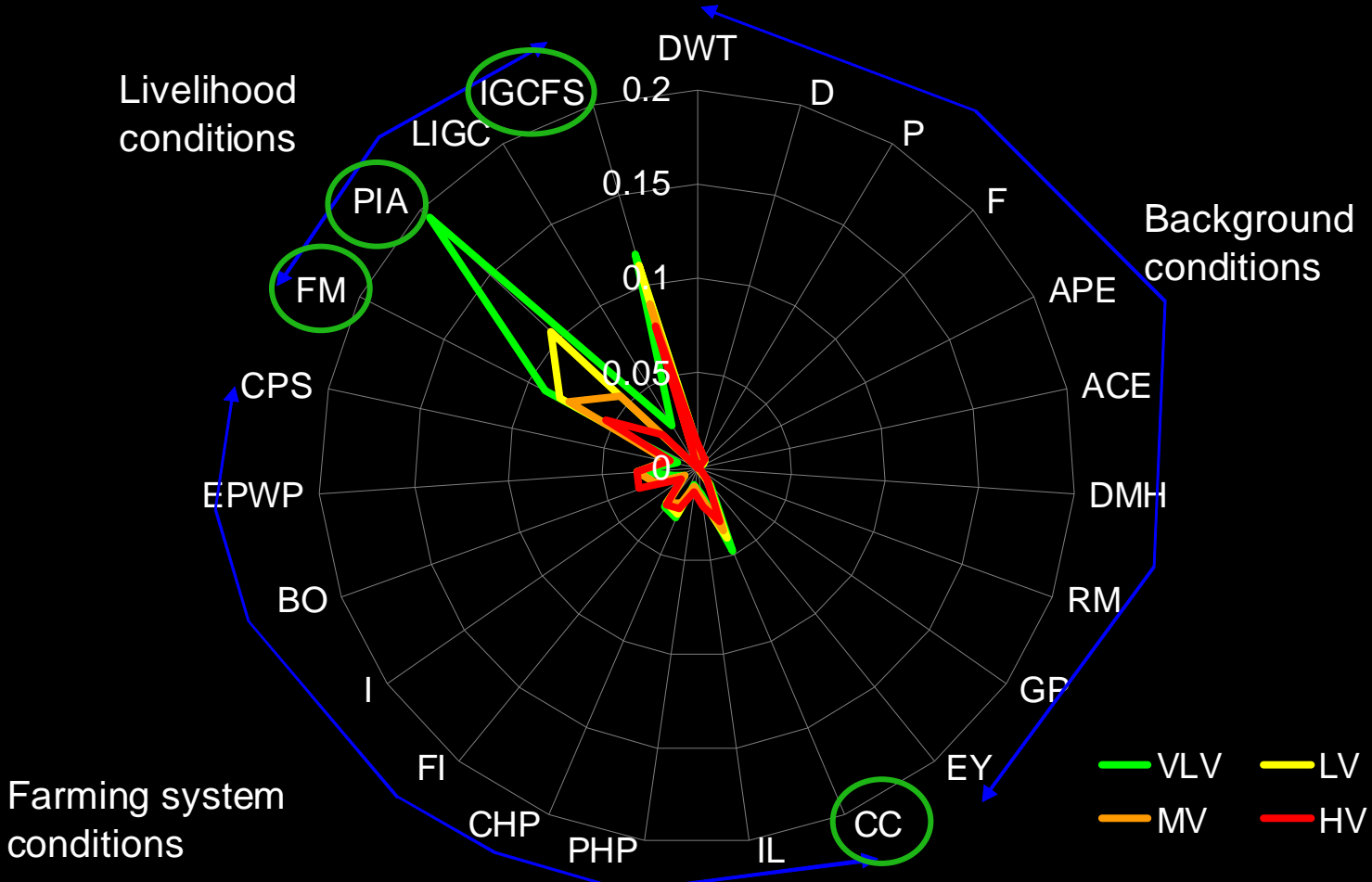
Veeranangar village



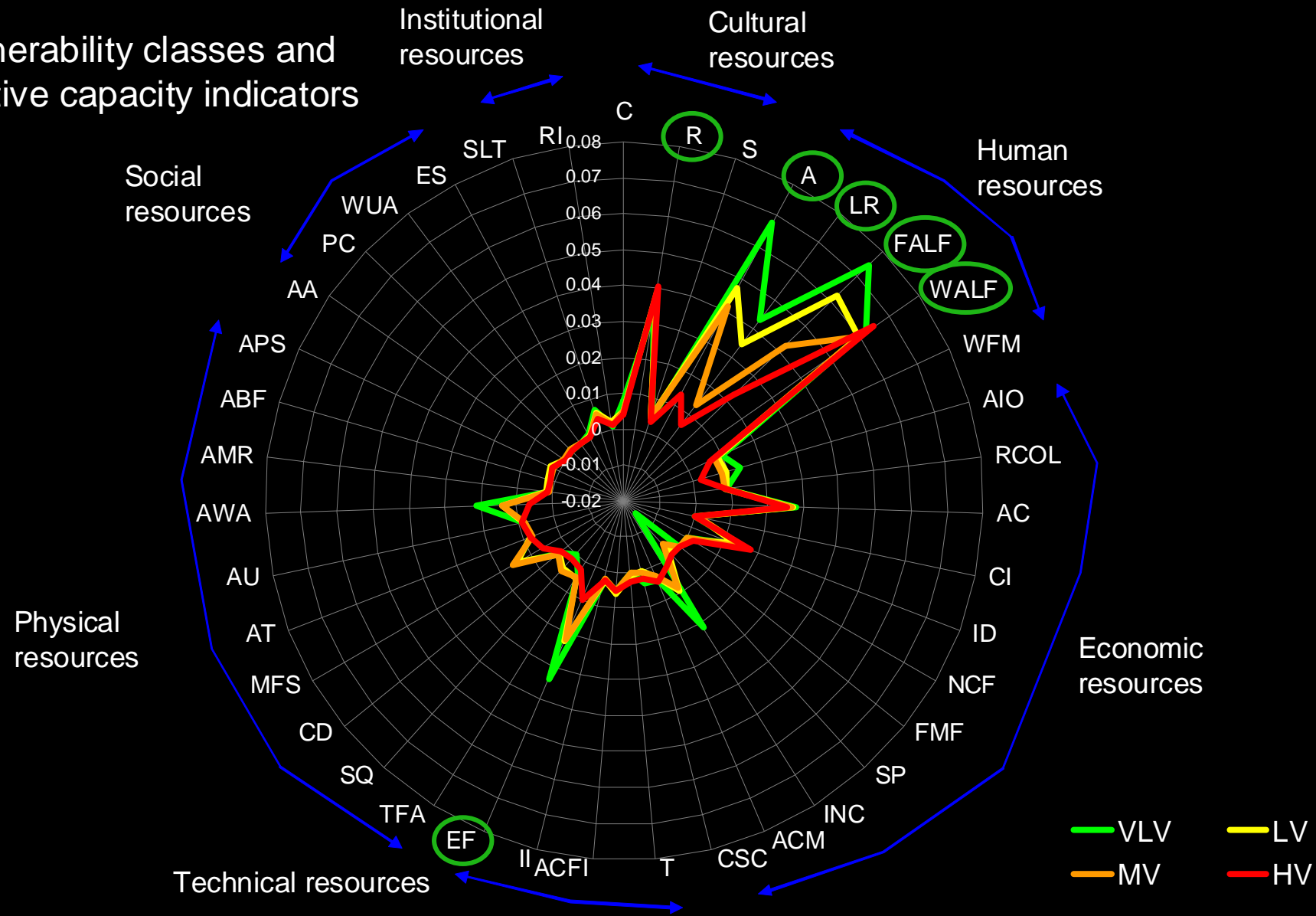
Half of the farmers are low vulnerable whereas another half are moderately vulnerable. In the current state, there are no “very high” vulnerable farmers within the basin.



# Vulnerability classes and sensitive indicators



# Vulnerability classes and adaptive capacity indicators



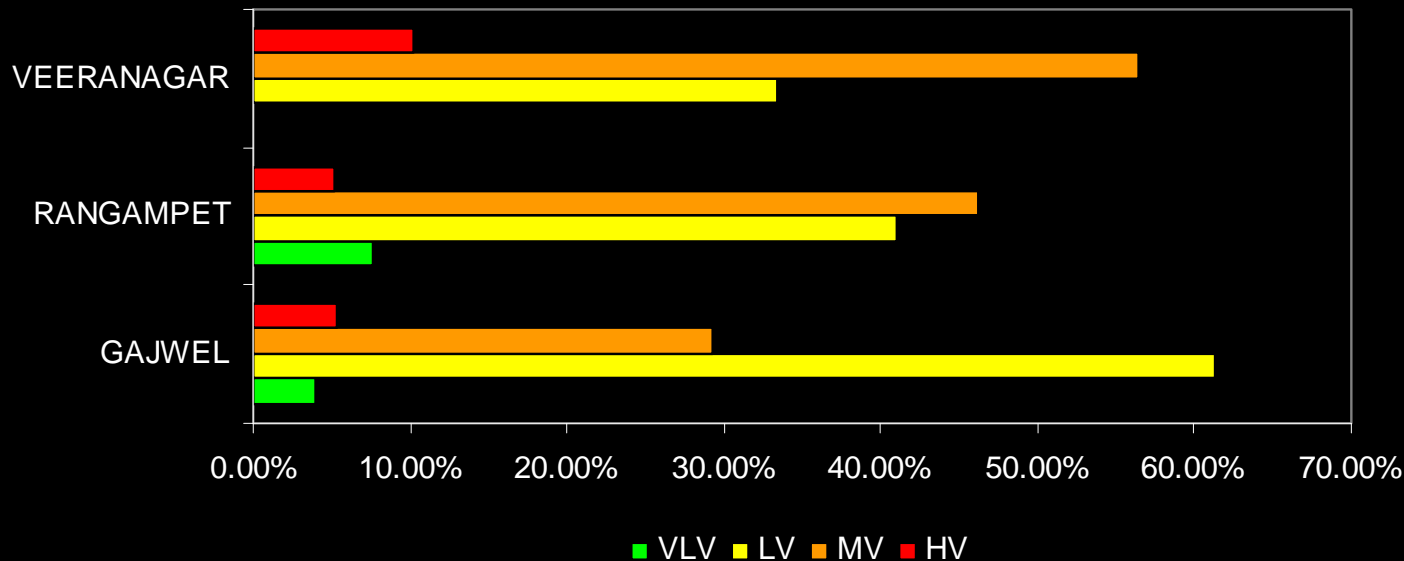
# Preliminary results (4)



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Vulnerability classes: number of Hhs per village



Gajwel farmers are less vulnerable than the two others: the more rural, the more vulnerable



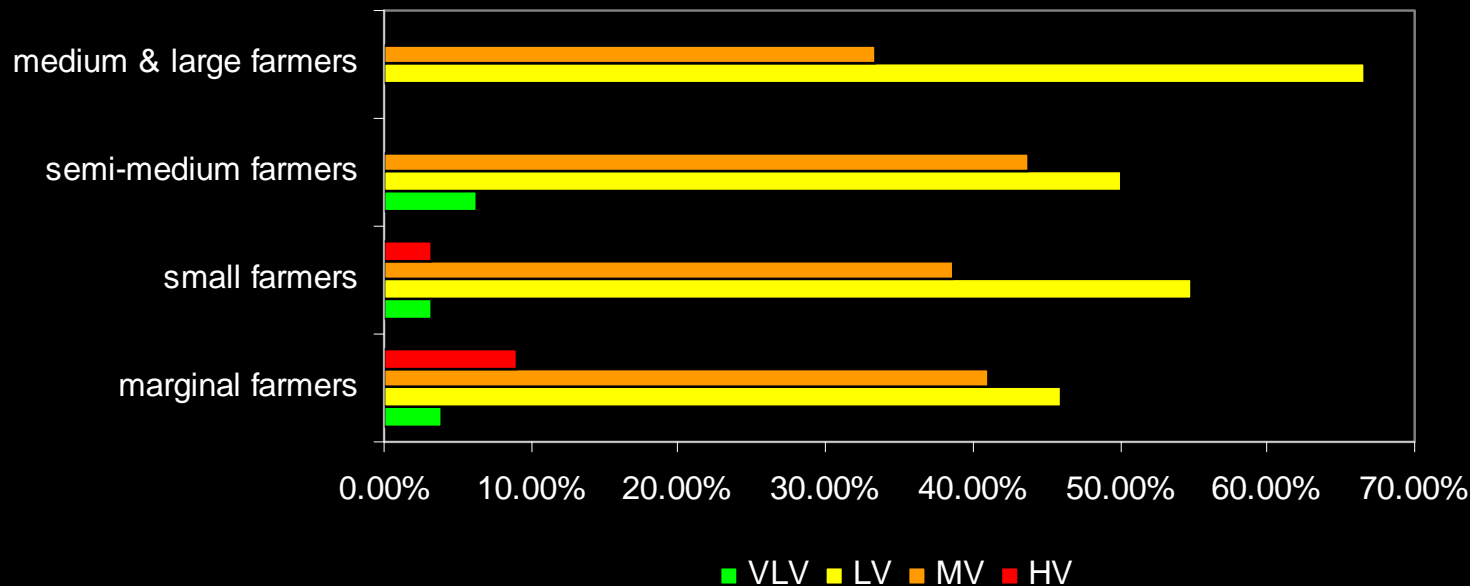
# Preliminary results (4)



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Vulnerability classes: number of Hhs per farmers' category



Marginal and small farmers are more vulnerable with a small proportion of high vulnerable farmers



# Conclusion

- Spent a lot of time in methodologies' choices as we needed to build an integrative framework
- SWAT modeling and webmapping will be 2 big challenges in 2010
- 3000 economic surveys are beginning now

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Thanks for attention!

