Catastrophic Modelling in Crop Insurance

Markus Konz, September 2019, Agriculture

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Crop Insurance in India

PMFBY – The Dominant Product in the Market

- Standardized product, predominantly based on the concept of yield index

- Covers certain other perils which can't be captured efficiently through indexing

- States decide the indemnity levels (70%, 80% or 90%) of the yield indices, depending on their view of the risk and also the availability of funds for subsidies

Post Harvest Coverage

Standing Crop (Sowing to Harvesting) - Area Yield Index Based Coverage

Localized Calamity

Mid Season Calamity

Prevented Sowing

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Mechanics of PMFBY

Threshold :
- Average Yield of the past 7 years excluding the 2 worst years (average of the green circles)

Payout :
- Sum Insured x (Threshold-Yield/Threshold))

Impact of Threshold Methodology

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Sensitivity to Thresholds

Year	Calamity?
2012	No
2013	No
2014	No
2015	No
2016	No
2017	Yes
2018	No

Threshold increase   3.3%

BC increase   6.5%

Impact: Increase in thresholds -> **significant increment in 'Pure Burn'**
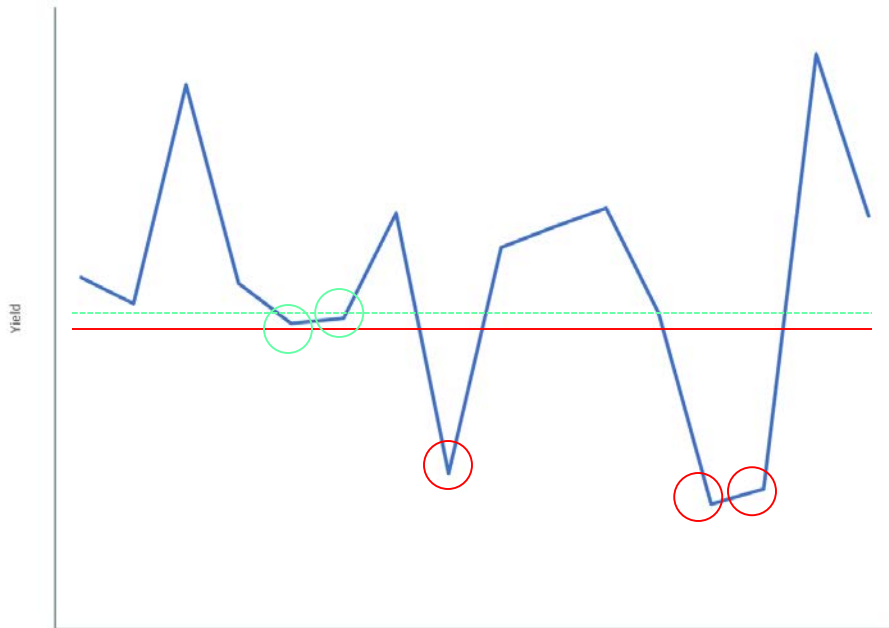
Pre 2018:
Thresholds based on minimum 5 of 7 years, with maximum two 'Calamity Years' excluded: 175 (80% indemnity)
Burn Cost: 12.4%

Post 2018:
Best 5 of 7 years data to be used for thresholds (new guidelines): 181 (80% indemnity)
Burn Cost: 13.2%

Key Components of Primary Crop Insurance Pricing

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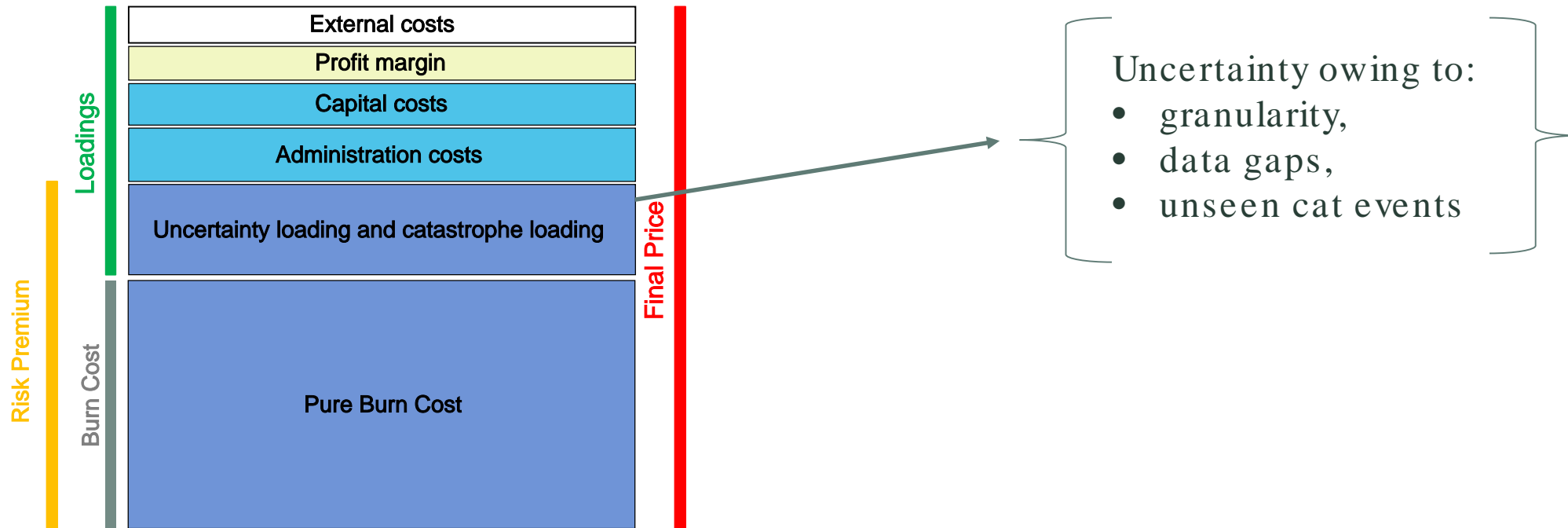
Risk Premium

Loadings

Burn Cost

Final Price

| External costs |
| Profit margin |
| Capital costs |
| Administration costs |
| Uncertainty loading and catastrophe loading |
| Pure Burn Cost |

Uncertainty owing to:
- granularity,
- data gaps,
- unseen cat events

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From BC to Risk Premium

Burn Cost

Heterogeneity*
Loading

CAT
Loading

Risk Premium

Heterogeneity as a Source of Uncertainty

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Heterogeneity/Granularity of Existing Insurance Scheme
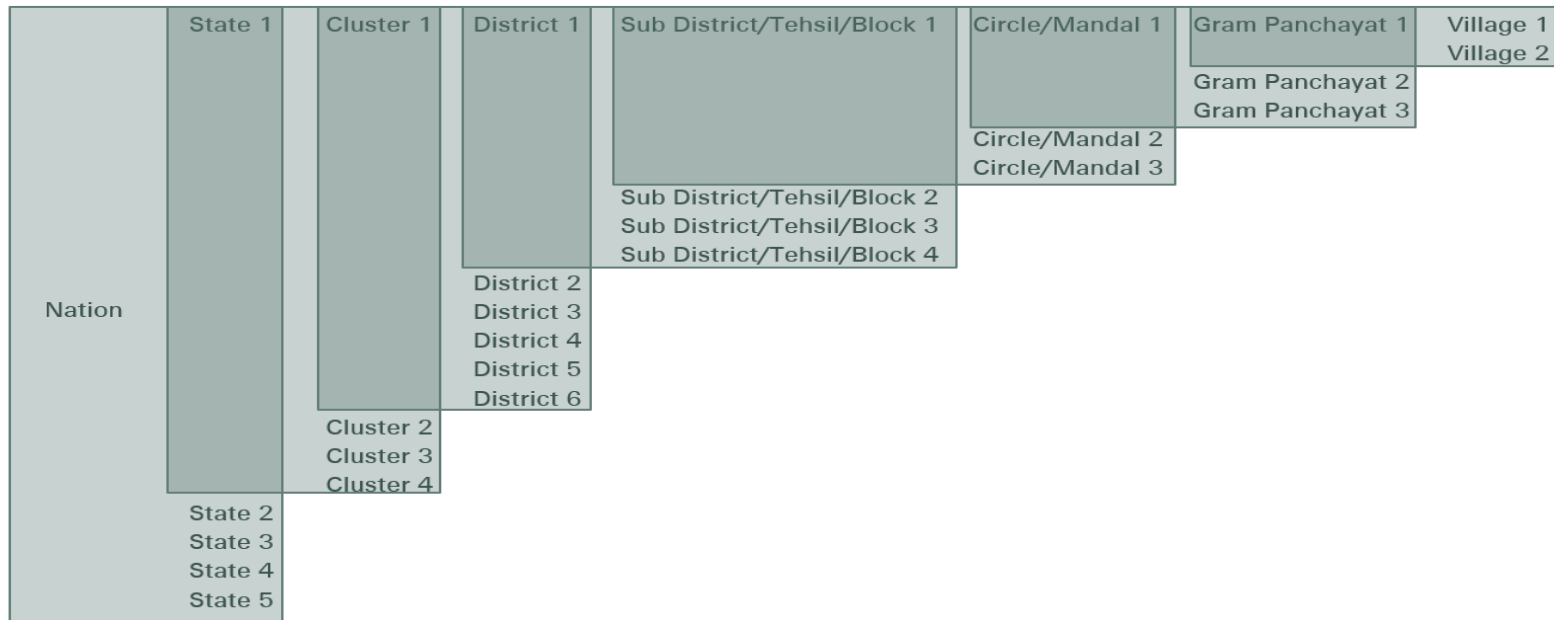
Not much emphasis on agro-climatic segregation.
Costs increase exponentially as granularity increases!
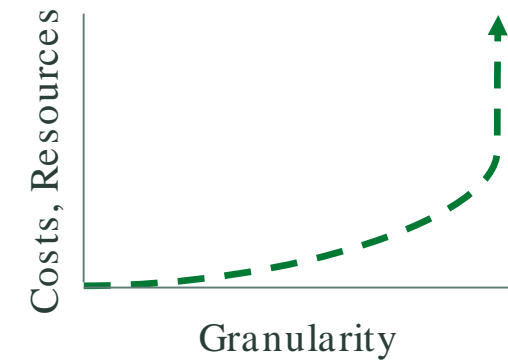
Typical Granularity Level of Yield Series
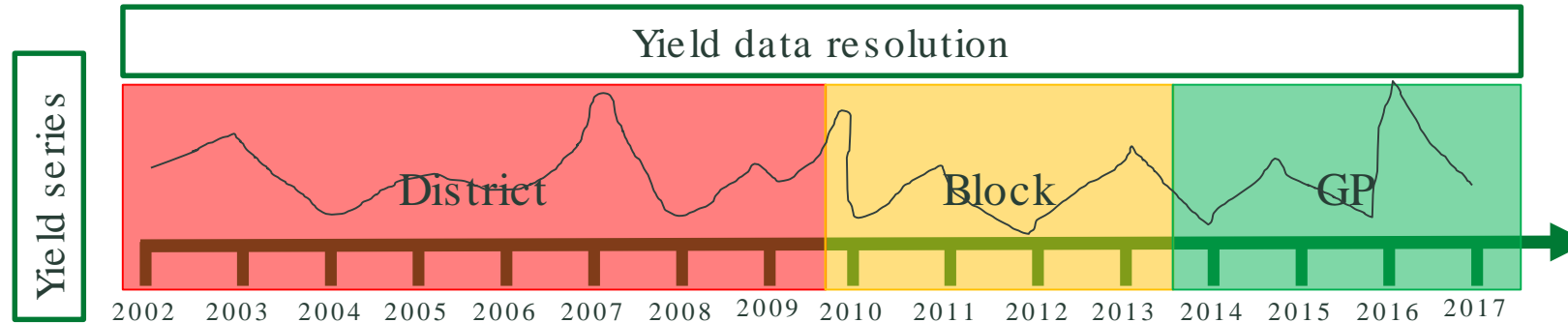
- Low volatility
- Miss-match between rate estimation and final loss settlement

- Data at loss settlement level
- adequate rate estimation possible

=> fair to the farmer, sustainable for the insurance industry

CAT Loading in Premium Calculation

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Basic Concept I - Beta Bistribution to Simulate Yields

Mean
Standard deviation
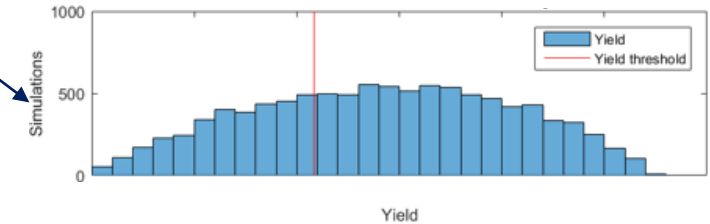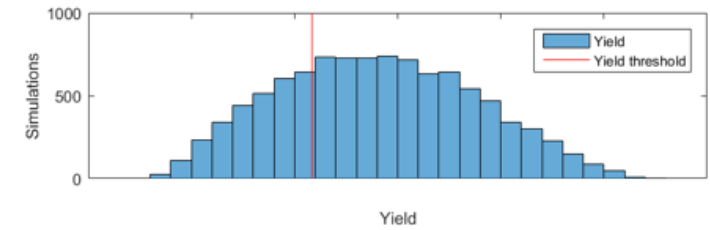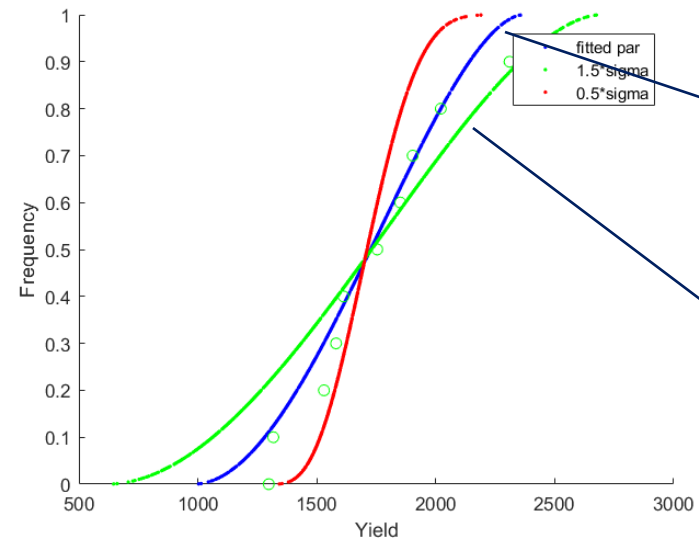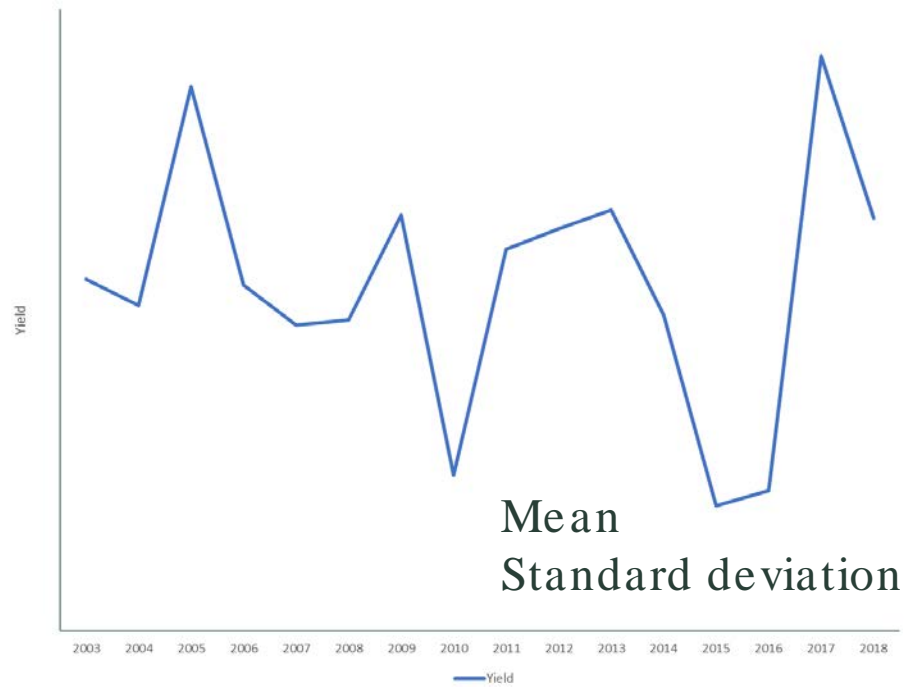
Basic Concept II - Crop Water Requirement Satisfaction Index (WRSI)

only 40% of the crop land is irrigated in India
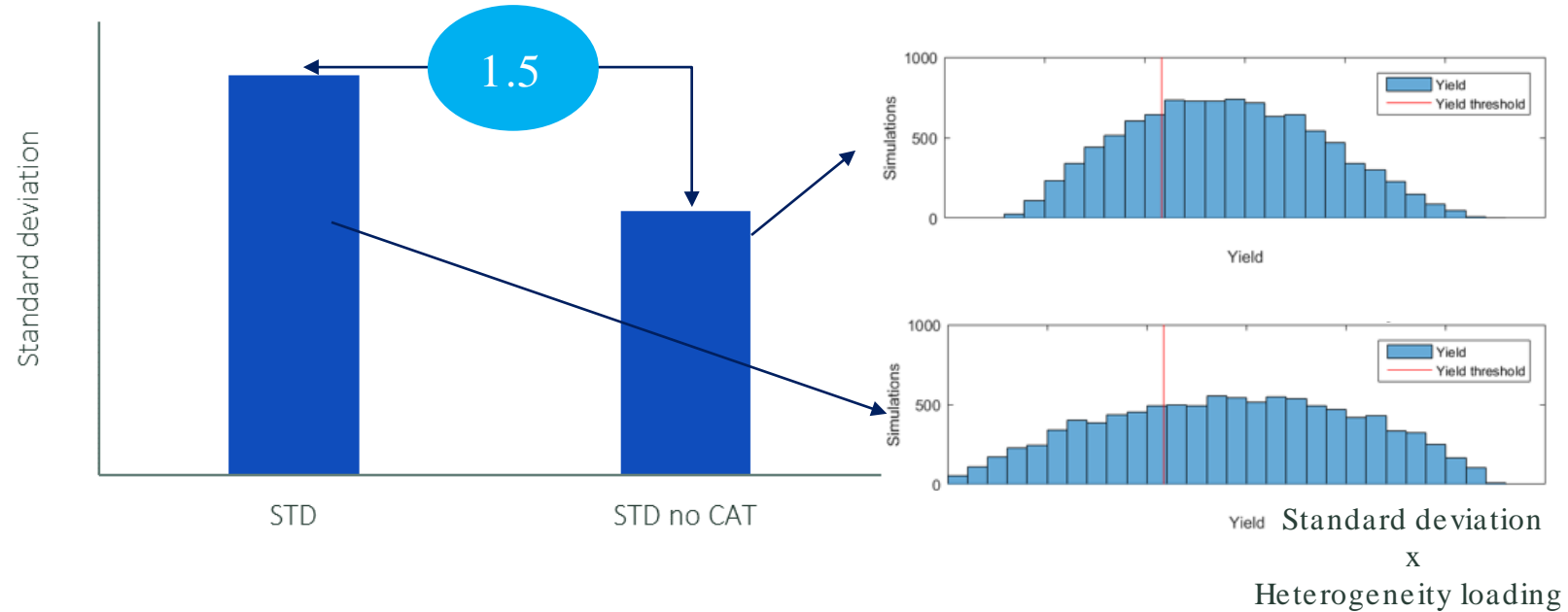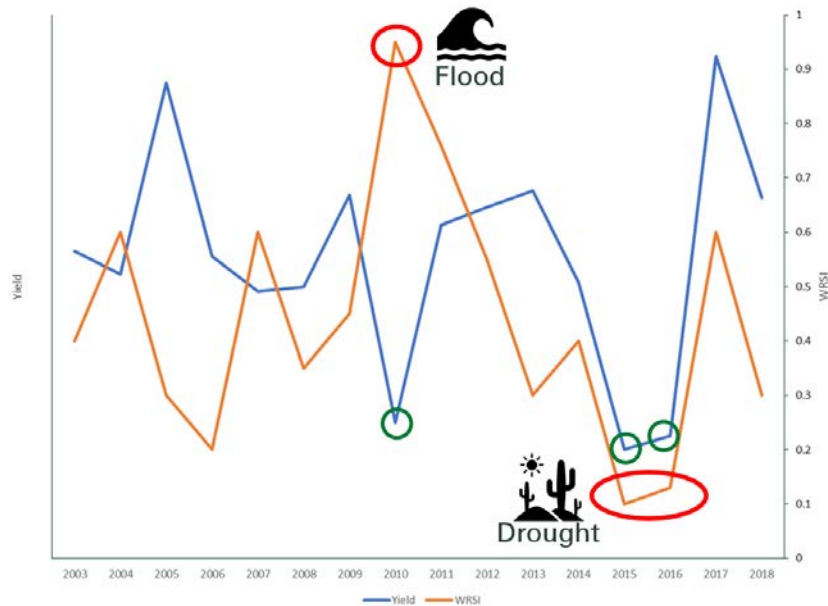
$$WRSI = \frac{\sum AETc}{\sum PETc} * 100$$
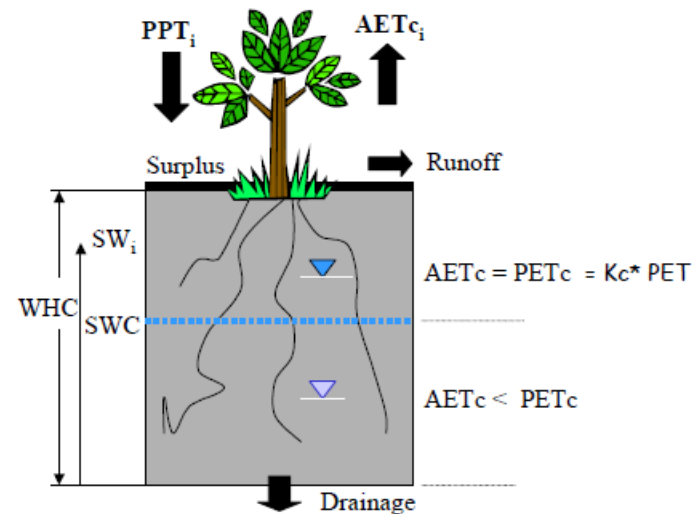
WRSI is an indicator of crop performance based on the availability of water to the crop during a growing season:

high WRSI: ex rain index
low WRSI: drought index
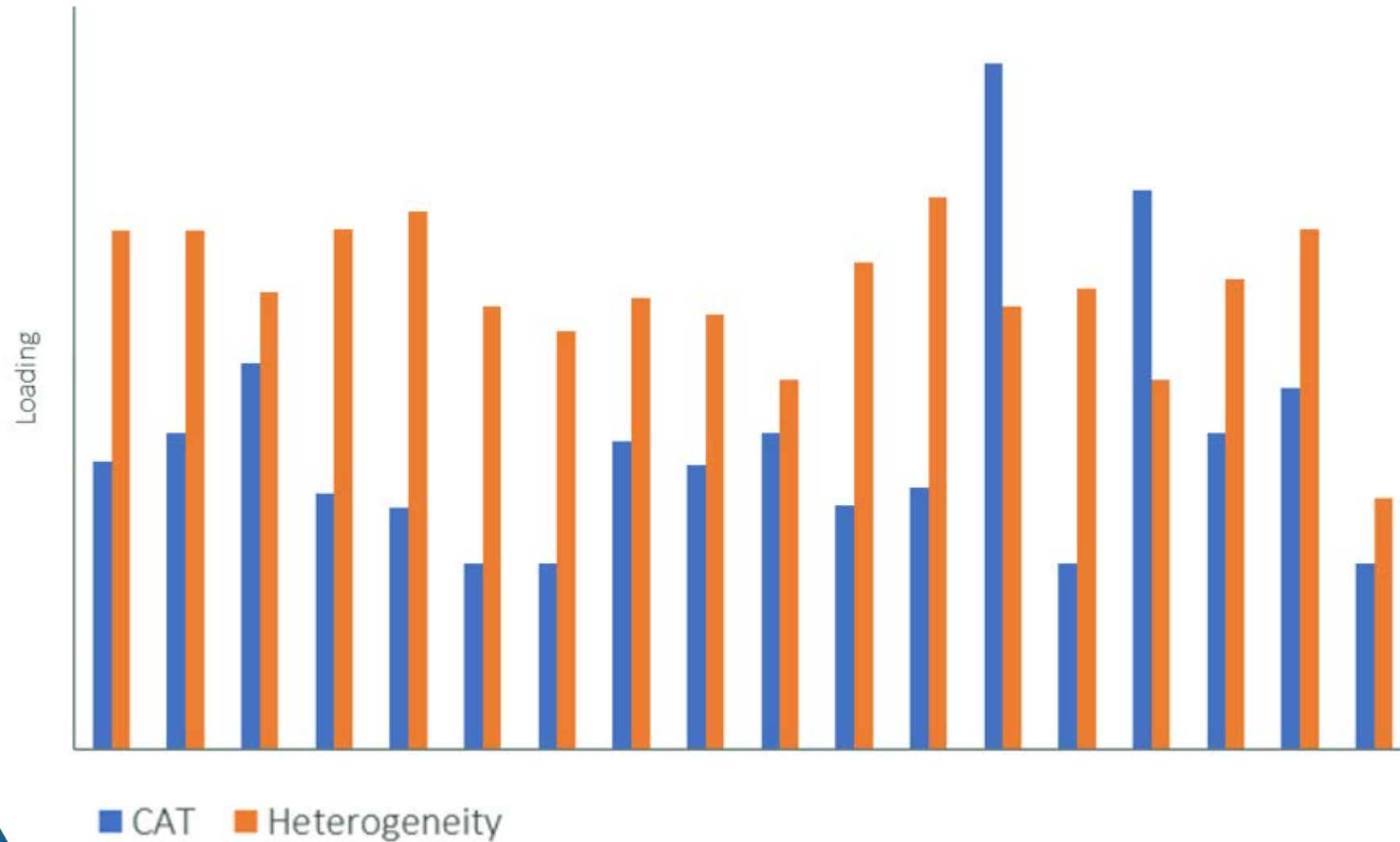
CAT Year Identification with WRSI
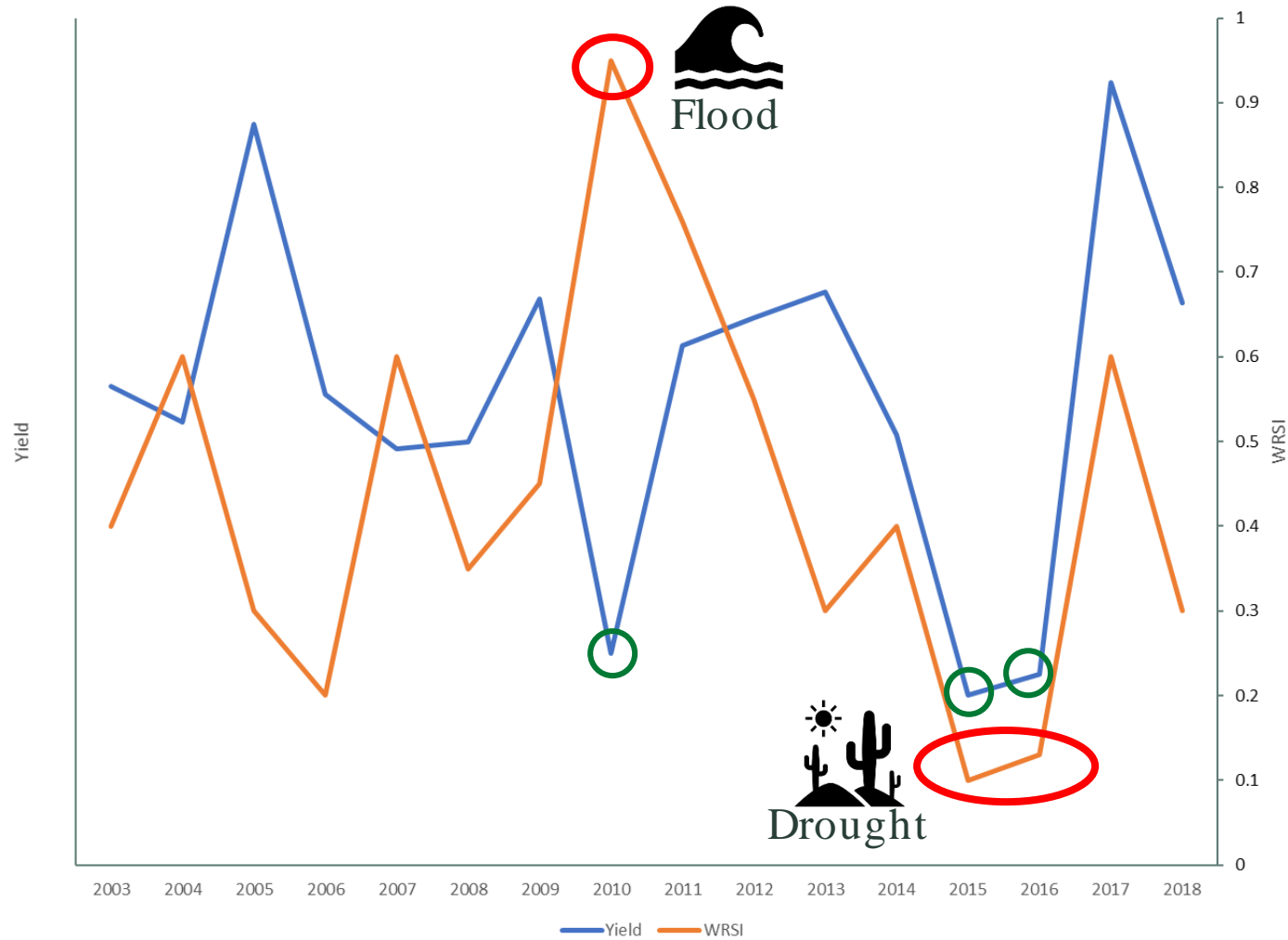
CAT Loading Estimation

Crop specific impact of CAT events on standard deviation is a factor of 1.5
=>Heterogeneity loading on standard deviation
Applied only to those yield series without historical CAT events

CAT & Heterogeneity Loadings

CAT   Heterogeneity

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Other Approaches/Alternates to WRSI

District	Sub District	Village	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
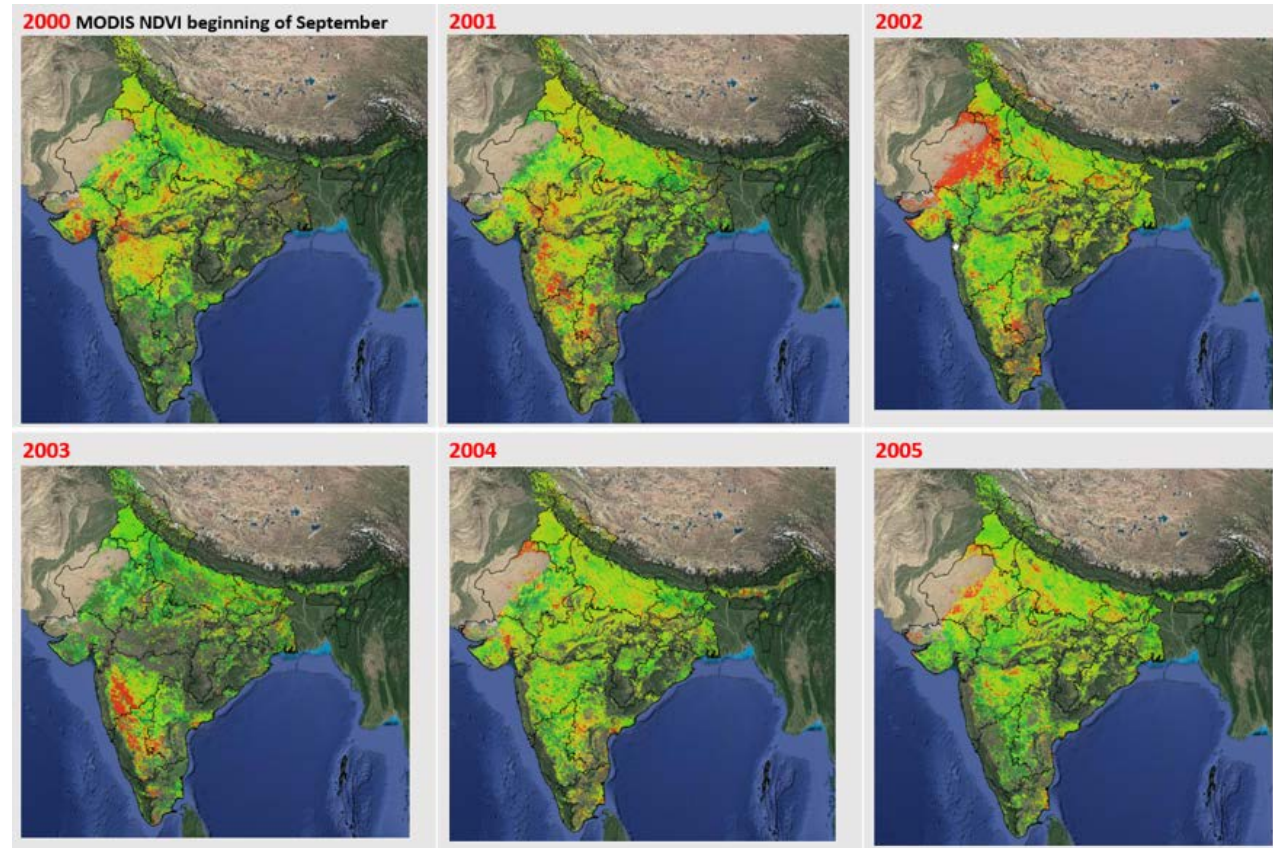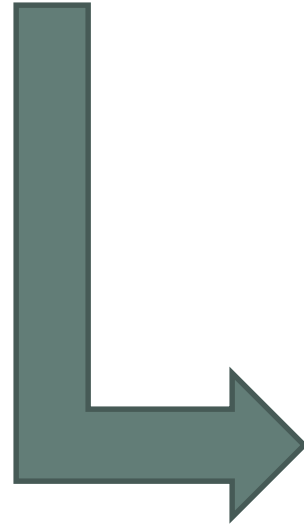
Other Approaches/Alternates to WRSI

Satellite data
38 years of global soil moisture data based on advanced satellite technology

Field level
High spatial resolution of 100 x 100 m

Daily observations
Soil moisture, ground temperature and biomass observations

Weather independent
Passive Microwaves technology sees through clouds
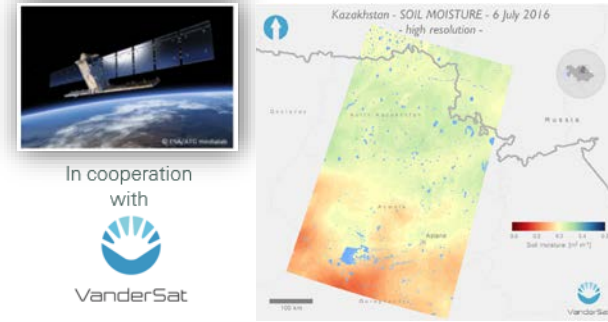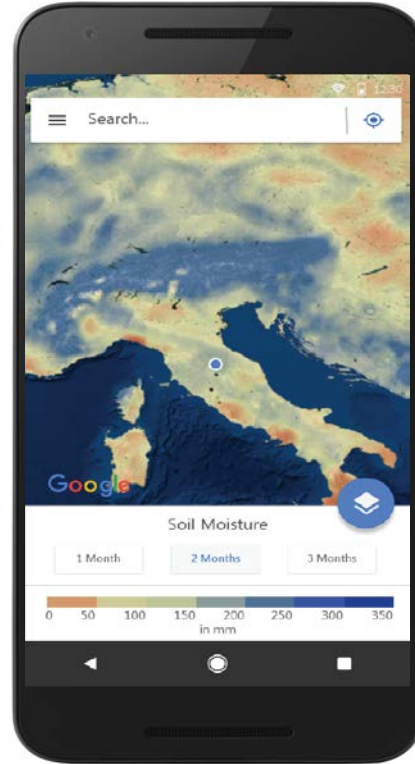
Conclusions

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- Key challenges in PMFBY pricing are:
  - **Heterogeneity load** estimation
  - **CAT load** estimation
- Pure burn cost is not adequate
- Lack of comprehensive, publicly available, single source of yield data
  => We need a **central quality controlled yield data set** at the highest possible granularity for all crops covered under PMFBY
- Administrative levels may undergo changes – thereby increasing mapping complexities. E.g. Telangana and new districts under it
  => We need **standardized GEO units** (like CRESTA zones) to ensure the reliability of our rates.
- Primary rates have to consider **CAT loadings** in those regions that have not suffered CAT events in the past 10 years

Thank you!

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