A user-oriented verification method for an operational forecasting model based on an economic decision model

19. April 2007

EGU in Vienna

by

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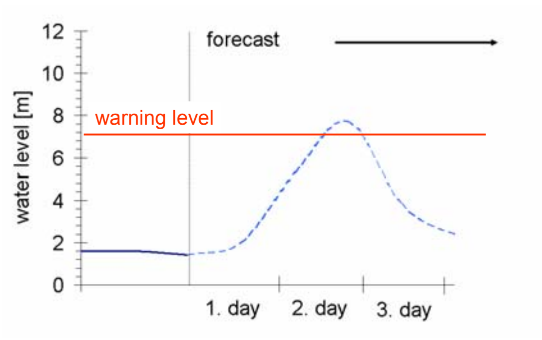
Deterministic Forecast



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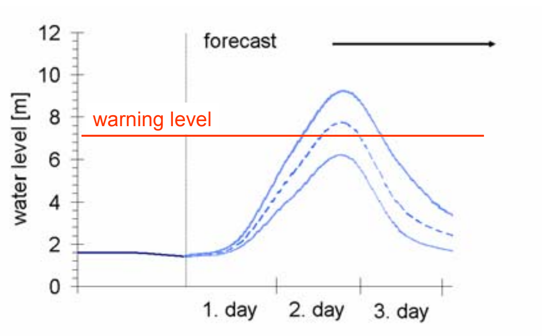
Probabilistic Forecast



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Results of a Decision Making Process

		Observation: Yes	Observation: No
Forecast	Yes	Hit	***False Alarm***
Forecast	No	**Miss**	Inverse Hit

⇨ To account the assymetric behaviour:
economic decision models
e.g. static cost-loss approach (Angström, 1922)

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Objective

(1) Is a probabilistic forecast useful for an end user?

(2) How should an end user handle a forecast to maximise his benefit?

(3) Can the static cost-loss approach be used to optimise a forecast model for extreme events?

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Static Cost-Loss Approach (Angström, 1922)

Alarm
Cost (*C*) for protection
Problem: false alarm

No Alarm
Loss (*L*), if an event is missed

⇨ **Minimise** costs (false alarm a + hit c) and losses (miss b)

$$E_v = \frac{a+c}{n}C + \frac{b}{n}L$$

⇨ average expense

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Economic Value V (Richardson, 2003)

$$V=\frac{E_0 - E_v}{E_0 - E_p}$$

Properties:

$-\infty < V < 1$

$V = 1$ perfect forecast

$V > 0$ better than reference forecast E_0

E_0: optimal strategy between { A: never protect / B: always protect

User Groups

Problem: different user groups

⇨ user can be separated by their **cost-loss rati**

Case 1: Local authority
Cost C of a false alarm = 100.000 Euro
Loss L of a miss = 10 Mio. Euro → $\frac{C}{L} = 0.01$

Case 2: People („Trust“)
false alarm = miss → $\frac{C}{L} = 1$

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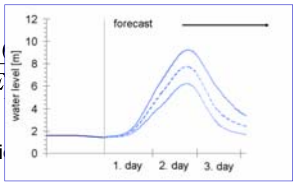
Economic Value V (Richardson, 2003)

$$V(\alpha, s, p) = \frac{E_0(\alpha, s) - E_v(}{E_0(\alpha, s) - E}$$



$\alpha = \frac{C}{L}$ cost-loss rati

p decision threshold $0 \le p \le 1$

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Economic Value V (Richardson, 2003)

$$V(\alpha, s, p) = \frac{E_0(\alpha, s) - E_v(\alpha, s, p)}{E_0(\alpha, s) - E_p(\alpha, s)}$$

$\alpha = \frac{C}{L}$ cost-loss ratio $0 \le \alpha \le 1$

p probability threshold $0 \le p \le 1$

s frequency of an event $0 \le s \le 1$

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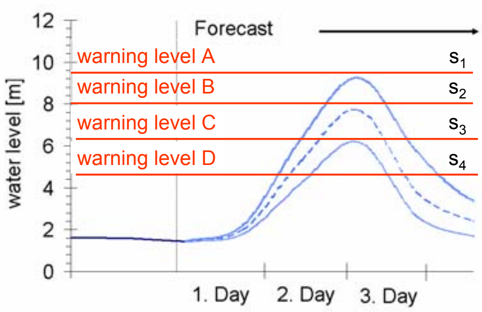
Probabilistic Forecast



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Optimisation for Extreme Events

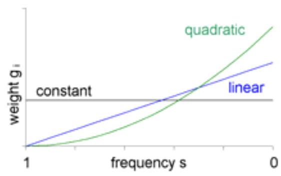
maximum economic value for a given s_i

$$V_{\max,i} = \max[V(\alpha, s_i, p)] \quad i = 1, n$$

mean maximum economic value

$$\overline{V}_m = \sum_{i=1}^{n} g_i \cdot V_{\max,i}$$

with $\sum_{i=1}^{n} g_i = 1$

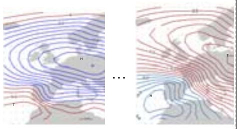


Probabilistic Precipitation Forecast

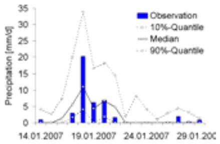
based on a statistical downscaling approach:

(1) Objective classification scheme to derive daily athmosperic circulation patterns

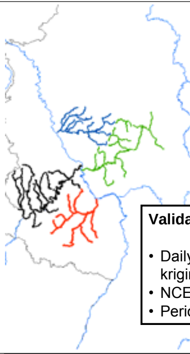
CP 1, … …, CP 12



(2) Analogue Method
For each circulation pattern the predictor domain and predictor weights are optimised



Test Site



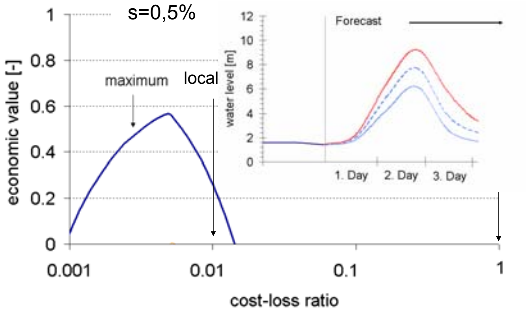
Mosel	Sieg
Area: 5800 km²	Area: 3450 km²
Height: 100 m – 600 m	Height: 55 m – 585 m
P: 850 mm/a	P: 1110 mm/a

Nahe	Lahn
Area: 4350 km²	Area: 6000 km²
Height: 120 m – 635 m	Height: 155 m – 655 m
P: 760 mm/a	P: 820 mm/a

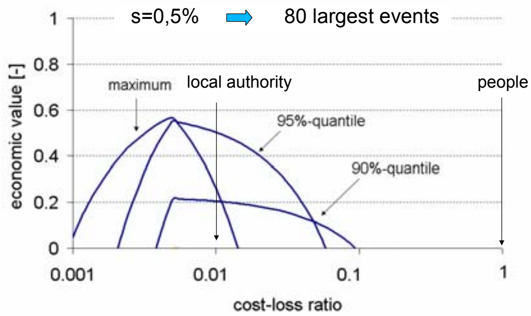
Validation

- Daily areal precipitation (5 km x 5 km, external drift kriging)
- NCEP/NCAR-Reanalysis data
- Period: 44 years (1958 – 2001)

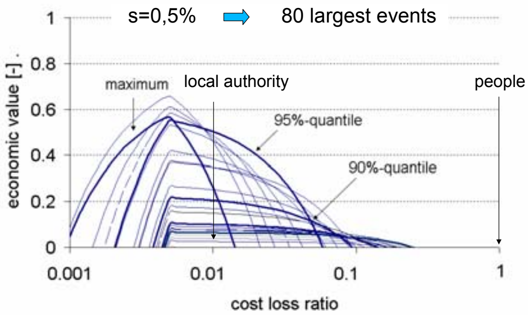
Results: Economic Value



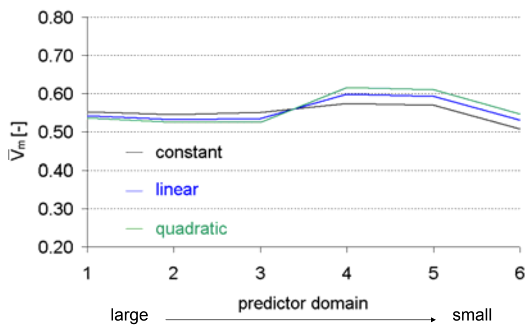
Results: Economic Value



Results: Economic Value



Optimisation for Extreme Events



Conclusions

(1) Value of a forecast model for an user can be derived by an economic decision model

(2) How a decision maker should handle a forecast to maximise his gain

➔ transfer the information to the user

(3) Application to other forecast variables (e.g. discharge) possible (static/dynamic cost-loss approach)

➔ be careful which reference forecast is chosen!

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