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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "GIS analysis of effects of future Baltic Sea level rise on the island of Gotland, Sweden" *by* Karin Ebert et al.

Anonymous Referee #2

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General comments: The paper deals with the impact on infrastructure, culture values and environmental values due to a sealevel rise amounting to 2 m by using accurate LIDAR level data in a GIS. The idea is good and the paper points out that the values will be heavily affected due to that much of values are located close to the coastlines. It's interesting with a multi-aspect paper but much is focused on increased salinization of groundwater. However, very little of data is presented and almost no calculations. But the work, so far is well done and this is something that the planning offices at the Gotland county should have done. It should have been nice to have a more quantitative estimation of the values or qualitative, pointing out where on Gotland the values are threatened at most. How is different values distributed and connected to the population density?

However, looking at the effects of sealevel rise it is important to consider not only land

which is inundated (as in the paper) but also land where drainage will be failed leading to less crop production. It is also inadequate just to look at median seawater level since the impact relates to the maximum height of wave actions. More extreme wave scenarios will probably be a result of the increased temperature.

The novel of the paper is the use of detailed LIDAR data for the GIS evaluation.

My concern is regarding the use of information for the RV method. It is not structurized, which it should be according to the principles behind the RV-method, instead uses factors and weights without critical discussion, handling those as if they represent a truth value of salinization risk (se more detailed discussion below). I suggest a major revision of this part and/or present data that support the use and choice of the factors.

Specific comments:

L 53-57 The statement that two dm change of the Baltic Sea-level leads to several meters loss of freshwater aquifer is wrong. Ghyben-Herzberg eq cannot be directly applied to the brackish waters in Baltic Sea due to the small density difference where other aspects such as temperature and circulation currents will be more important and lead to a very broad mixed zone. And it is not at all applicable to heterogeneous aquifers (crystalline rocks and sedimentary rocks) prevailing around the Baltic Sea. No reference for the statement is presented.

160- Experience from field measurements indicate that there is not a groundwater surface existing on Gotland but a unique groundwater pressure level at each well depending on it's specific depth, geological structures (fractures, stratigraphy, karst) etc. The level varies with season, sometimes up to 20 m. The well data gives probably information just from the time when the specific well was constructed (I can't find it mentioned in the text), since I assume it is based on the well archieve at SGU. Can we then make a groundwater surface and rely on what it represents?

The method used refers to the RV-method and the authors explain that the parameters and the weighting used are similar to what previously been developed for Sweden and Gotland. However, the authors have unfortunately not understood the dynamics of the RV-method. The factor values should be ranked from negative to positive values since it is the extreme conditions that will have a most significant influence on the results. The RV-method also comprises an uncertainty evaluation in the same manner and factors and weighting should be based on a multistatistical evaluation of existing data from the specific type of terrains that is studied. No such statistical analysis is mentioned. How can we know that the factors selected for Gotland are the most appropriate and that the weighting is statistically correct? The method might have been inspired by the RV-method but cannot be presented as a prolongation of the method.

The papers present five factors included in the risk analysis for saltwater intrusion with reference to a non-published undergraduate report. The choice of factors is therefore unclear. However, a statistical analysis of drilled wells at Gotland made at KTH (Pirnia A, 2012, TRITA-LWR MSc degree project 12:12) shows that two of the variables used in the paper have no statistical significant to chloride wells on Gotland. Two other factors not used in the paper (type of bedrock and landuse) show instead significant correlations to chloride content in the wells. Chloride affected wells are in reality spread all over Gotland since most of the chloride comes from fossil seawater, not from recent seawater intrusion. The method used gives a too high weight to the distance from the shore. A paper submitted to Environmental Earth Sciences shows that the chloride situation on Gotland is much more widespread than is shown in Figure 6 (I enclose a statistical analyses and a GIS map based on the RV-method - not yet scientifically published -cannot be cited)

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Table 1. Results of Kruskal-Wallis ANOVA by ranks for chlorid

factors	significance level,p	classess	chloride median value mg/l
landuse at well location	0.0764	Urban area	16.00
		field	49.50
		forest	25.50
soil type at well location	p=0.901	Till	68.000
		Sand & Gravel	26.000
		Bedrock	35.000
		Clay & Silt	12.000
		Organic.material	38.000
Bedrock at well location	0.0013	Marlstone	53.00
		Limestone	23.00
soil depth	p=0.3	very low	59.000
		low	36.000
		medium	35.500
		high	16.000
elevation	p=0.0008	0-20 m	55.000
		20-40 m	26.000
		40-60 m	11.000
		>60 m	8.300
distance to saline water	0.048	0-100	250.000
		100-500	34.000
		500-2000	36.000
		>2000	31.000
slope	p=0.46	0-2 deg	36.000
		2-5 deg	16.000
		>5 deg	
distance to deformation	p=0.28	0-50 m	12.000
		50-100 m	14.000
		100-200 m	35.500
		200-500 m	56.500
		>500 m	36.000
p<0.05	p<0.1	p<0.2	

Fig. 1.

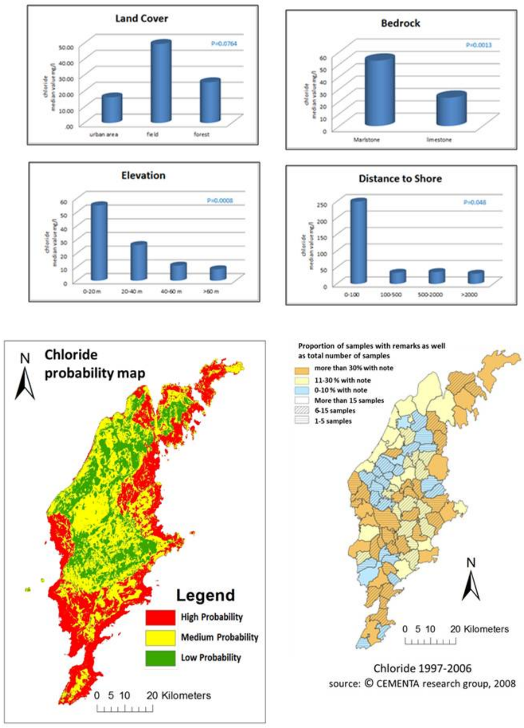
Land Cover
P=0.0764
chloride median value mg/l
50.00
40.00
30.00
20.00
10.00
.00
urban area
field
forest
Bedrock
P=0.0013
chloride median value mg/l
60
50
40
30
20
10
0
Marlstone
limestone
Elevation
P=0.0008
chloride median value mg/l
60
50
40
30
20
10
0
0-20 m
20-40 m
40-60 m
>60 m
Distance to Shore
P=0.048
chloride median value mg/l
250
200
150
100
50
0
0-100
100-500
500-2000
>2000
N
Chloride probability map
Legend
High Probability
Medium Probability
Low Probability
0 5 10 20 Kilometers
Proportion of samples with remarks as well as total number of samples
more than 30% with note
11-30 % with note
0-10 % with note
More than 15 samples
6-15 samples
1-5 samples
N
0 5 10 20 Kilometers
Chloride 1997-2006
source: © CEMENTA research group, 2008

Fig. 2.