Supplement

1. IMPACT ASSESSMENT FOR DIFFERENT CRITERIA

Water levels

Forestry ditches have changed the groundwater exfiltration patterns in the Rokua groundwater discharge area. How much these changes have actually affected the groundwater levels is currently under research and remains uncertain. For the MCDA, the best current available information derived from hydrological studies was used to assess how the water levels would behave during the following 30 years according to the different alternatives (Table 3). If the current state prevails, the long-term decline of water levels will continue and may cause a water level decline of approximately one meter (from the average value) within 30 years. During dry periods this would mean a lower minimum in water levels that could be more drastic than during the dry periods of the 1980s and the 2000s. In Alternative A, the long-term decline of water levels is halted, but water levels would not revert to the level preceding the ditching. In Alternative B, the water levels revert to the assumed natural state, on average one meter higher than the current situation. This level is indicated by the shoreline region occupied by the oldest trees. This alternative can be estimated to be less uncertain in comparison with Alternative A, as there are active procedures aiming at restoring the groundwater exfiltration patterns to the natural state.

Ecological state of lakes and springs

Preliminary studies of the groundwater / surface water interaction in Rokua have indicated that phosphorus is leaching into the groundwater from the sandy soil, especially when the groundwater has had a long contact time with the sand (i.e. old groundwater). As the clear oligotrophic kettle lakes are groundwater dependent, the risk of eutrophication increases due to the water level decline. The risk increases as older groundwater might seep into lakes and increase the proportional amount of incoming phosphorus. Also, lake water volume decreases due to the water level decline, thereby increasing the proportional amount of phosphorus entering lakes.

Another ecological issue is that the ditches have dried up natural springs, which have formerly acted as natural groundwater exfiltration locations in the peatlands surrounding Rokua. As they are dry, the current ecological state of these spring ecosystems is poor. If the ditched areas are restored, the springs will most probably revert to a more natural state. Spring locations have not been mapped thoroughly, and therefore the question of how many springs can be restored increases the

uncertainty of this factor. The ecological status of both lake and spring ecosystems are predicted to have a positive impact as a result of implementing Alternatives A and B.

Recreational value of second homes

One of the key factors of the recreational value of Rokua is the pristine, clear-watered, oligotrophic kettle lakes. Fifty-three second homes have been built on the shores of these lakes and the recreational value of these houses is partially dependent on the shoreline. The water level decline moves the shoreline further from the houses and reveals former lake bed areas. This decreases the recreational value of the lakeshore as thickets start to grow and the pristine landscape changes. The link between the recreational value of second homes and lake water level was calculated using the VIRKI model. The model was originally developed to calculate the effects of water level variation on property values on lake and river shorelines (Keto et al., 2005). In the case of Rokua, the model was used to calculate how much the recreational value decreases if the shoreline recedes from the situation in 2008. In 2008, lakes no longer showed significant effects due to the previous dry years, and the water levels were close to the average of the past 30 years. In the current state, the water level is presumed to decrease by approximately one meter, which would cause a shoreline retreat of approximately five to six meters. This retreat would cause an annual decrease in the recreational value of 94–145 € for each of the second homes. During 30 years this would mean a 150,000 € to 230,000 € decrease in the recreational value. In Alternative A, the decline would presumably stop, but as the future level variation is uncertain, the value decrease is assumed to be somewhere between 0 and 230,000 €. In Alternative B, the water levels should revert to a more natural state and the levels are assumed to match with the situation in 2008 or to surpass it.

Attractiveness of Rokua area

The lakes are another key factor in the attractiveness of Rokua for tourism. Lake level decline might change the landscape and the recreational use of the lakes. This again might reduce the amount of visitors in Rokua. As the lakes are only one part of the landscape in Rokua, and tourism is not only dependent on lakes, the impact of the lake level change is considered to have less of an effect on tourism than, for example, on the recreational value of second homes.

Economic impacts on forestry income

The impacts of the restoration of drained peatland areas on the forest economy were studied by using exfiltration risk analysis maps (Fig. 3). Watersheds in high exfiltration risk areas were defined as areas where active restoration procedures in Alternative B would be allocated. In these areas

restoration is presumed to wet the forest and affect tree growth. As the growth potential of the forest is drastically reduced, the income of the forest owner is diminished. Using different input data (different combination sets of available data, Fig. 3) in risk scenario maps (Eskelinen, 2011), the value of income losses during 30 years was calculated to vary from 500,000 € to 2,500,000 €. The change in land value was not taken into account. In Alternative A, where the groundwater area is expanded, defining the forestry income loss was more problematic. As the expansion would restrict forestry management practices in some of the areas where the groundwater area is expanded, some new areas might become wet. As this is less certain it was estimated that Alternative A would result in only 10% of the effect on forestry compared with Alternative B.

Income loss of peat production

Peat production in the vicinity of Rokua is scheduled to end in 2018. Also, hydrological studies have showed that approximately 1% of the groundwater discharging from Rokua is flowing from the harvesting area. This emphasizes the minimal effect of the harvesting area on the whole Rokua esker hydrology. Therefore, different scenarios are presumed to have only a small effect on peat production. In Alternative A, peat production may end earlier in the case that the groundwater area expands to the peat harvesting site. In Alternative B, a new method is planned for the restoration of the peat harvesting area to prevent groundwater exfiltration to the harvesting site. This again might be more expensive than the current methods and reduce income from peat production.

2. PREFERENCE ELICITATION IN THE DAI APPROACH

The following approach for gathering preference information from each stakeholder with four key questions on each criterion has worked fairly well within the DAI approach. This description is adapted what we wrote in from Marttunen et al. 2013 (pp.123–24):

In the first question, it is asked how important the objective related to the criterion is in general from the respondent's point of view using a scale from "not important at all" to "very important". For example, in the Rokua case, we asked how important it is to protect the natural variability of the groundwater level and the water levels of the groundwater dependent lakes in the Rokua area. In the second question, we present the alternatives on a line having the end points −100 and 0 in the case of a negative impact, and 0 and +100 in the case of a positive impact. The preliminary values of the alternatives are defined by the decision analyst and the experts so that the worst and the best alternatives are placed on the end points of the scale and the other alternatives somewhere between showing their performance relative to the best and worst alternatives. Then, we ask the respondent

to agree or disagree with the given ranking order and the relative differences between the alternatives and, in the case of disagreement, to give his/her own opinion and arguments for that. In the third question, we present the experts' estimates on the magnitude and spatial extent of the maximum impact by using a 5-point scale and again ask the respondent to agree or disagree with these as well as to provide his/her argumentation for this. Finally, in the fourth question, we ask the stakeholder to evaluate the overall significance of the criterion based on the previous answers. The question asked here is ”How significant is the difference between the best and worst alternative from your perspective, if you take into account both the importance of the objective and the impact range described above”. Here, too, a 5-point scale (”not significant at all”–”very significant”) is used. With this approach, the respondent has to consider the two main elements of the overall significance (i.e. the general importance of the criterion and the range of the possible impacts on this criterion) in a structured way when determining the value for the overall significance.

At the end of the questionnaire, the results of the assessment are collected into a summary table. Based on this table, the respondent is asked to give 100 points to the most significant criterion and a smaller number of points to the other criteria indicating their relative significance compared with the most significant criterion. The actual weights of the criteria are calculated from these points. With this kind of an approach, we are able to systematically provide the respondent with all the information that is needed to make justifiable judgments about the significance of the criteria. In this approach, we first carry out the evaluation of the alternatives in terms of the criteria and, only after this, the weighting of the criteria. We think that in this way the respondent is able to better give such weights that reflect the ranges of the criteria, which is required for the integrity of the method, as otherwise the weights may rather indicate the general importance of the criteria.