A Bayesian Belief Network approach to assess the potential of non-wood forest products for small-scale forest owners

Vacik, H.[1], Huber, P.[1,2], Hujala, T.[3], Kurttila,M.[3], Wolfslehner, B.[1,2]

1… University of Natural Resources and Life Sciences Vienna (BOKU)
2… European Forest Institute Central-East European Regional Office (EFICEEC) 3… Natural Resources Institute Finland Bio-based Industry and Business (Luke)

Rowan
(Sorbus aucuparia)

Stone pine
(Pinus cembra)

Mushrooms
(Boletus pinophilus)

1. Introduction

Non-wood forest products (NWFPs), i.e. *products of biological origin other than wood derived from forests, other wooded land and trees outside forests* (FAO, 1999) are an integral element of sustainable forest management in Europe. In the wake of contemporary international policies NWFPs are being considered as important means for business diversification and income generation, particularly in regions where wood is not the most profitable product. In the most recent State of Europe´s forests report, the total economic value of NWFPs in the Forest Europe region accounted for 2,7 mio €. Thus there seems to be high latent potential to strengthen the economic viability of rural economies.

In this context we **aim** to:

- support people who give advice to forest owners (e.g. forest extension services, forest owner associations, forestry consultants) to
  - attract forest owners to engage in new NWFP businesses and
  - foster the sustainable management of forest resources
- support small-scale forest owners as regards the co-production of wood and non-wood forest products in order to
  - diversify their product portfolio
  - distribute related socio-economic risks
  - contribute to biodiversity conservation

2. Method

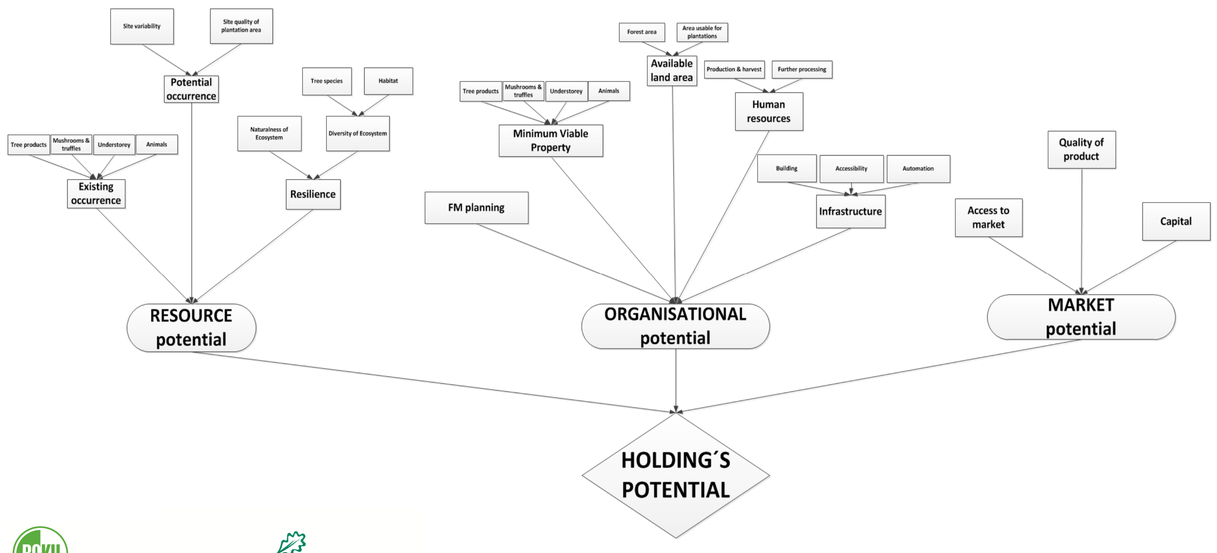
In our application, the BBN is applied in order to shed light on a FMU´s potential to integrate one or more of regionally available NWFPs in its forest management concept.

A Bayesian Belief Network (BBN) is a kind of probabilistic graphical model that may be applied to a wide range of environmental problems, inter alia due to the powerful probability theory involved. BBNs are understood as useful tools to model ecological predictions and to aid resource-management decision-making. They consist of two structural components:

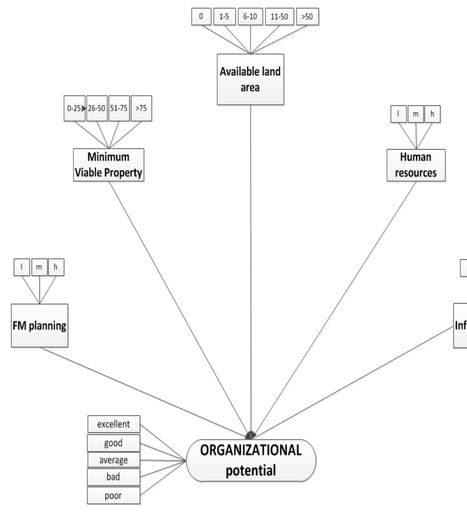
i. a causal network (often referred to as the directed acyclic graph), and

ii. conditional probability tables (that quantify the relations in the network)

i. Causal network

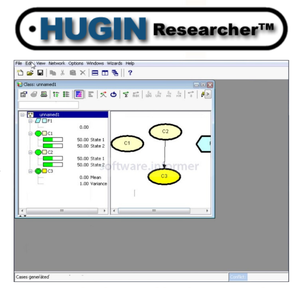


ii. Conditional probability table



Expert knowledge

CPT calculation

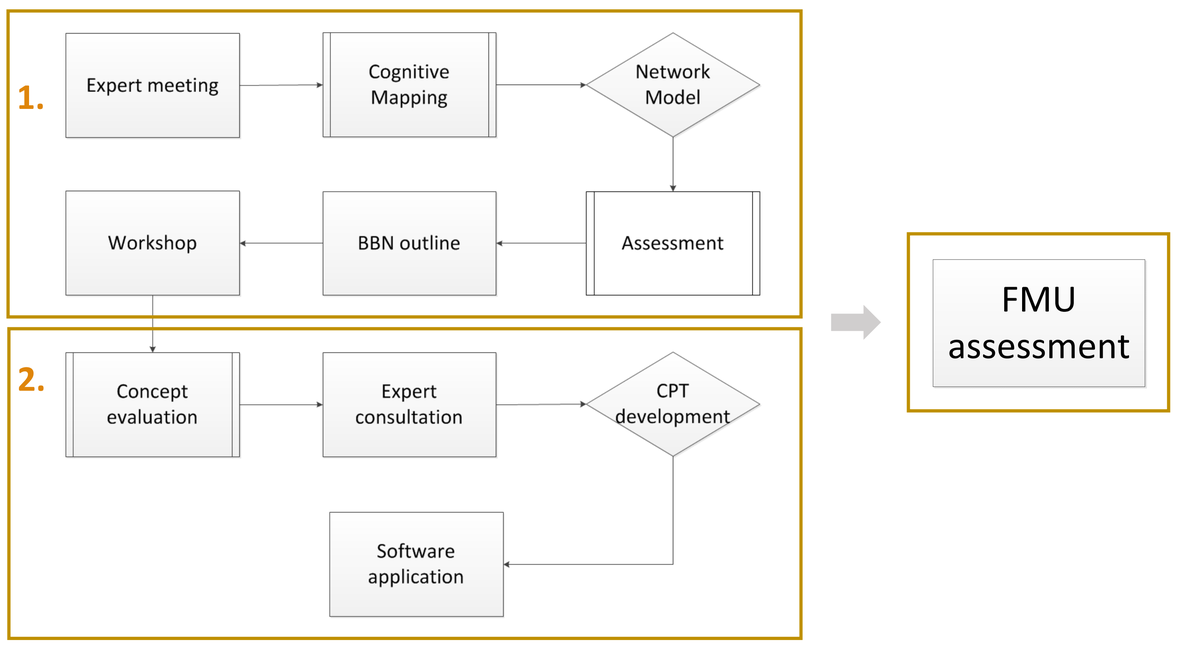


Model walkthrough

3. BBN development

The development process can be clustered in two main steps:

1. Structural development
2. Parameter estimation and quantitative evaluation



(1.) In an initial meeting, led by a domain expert, cognitive mapping was applied to identify relevant criteria and their relationships in order to design a basic structure of the BBN. The suitability of the network was assessed with regard to data needs for single NWFP species. In the following criteria were refined and the BBN structure adapted within a two-day workshop by the core development group. Further development was based upon two distinct case studies (i.e. North Karelia in Finland, Styria in Austria). (2.) Currently, the BBN is evaluated against its feasibility and applicability to be applied to 4 clusters of NWFPs (tree products, mushrooms & truffles, understorey products, animal products). Domain experts will be consulted in order to fill the conditional probability tables (CPT) for each criteria and each NWFP cluster respectively. An approximation approach is used to feed the CPT values into the HUGIN software and to reduce the elicitation burden of the experts using the R package. Finally, the approach will be tested on the level of a Forest Management Unit (FMU) for each case study.

Cork
(Quercus suber)

Chestnut
(Castanea sativa)

Honey
(Apis mellifera)

University of Natural Resources and Life Sciences, Vienna

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Luke
NATURAL RESOURCES INSTITUTE FINLAND

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