OSCAR a (very) short introduction to Bayesian Belief Networks

A Bayesian (Belief) network – BBN – describes probabilistic relationships between variables. These variables are called nodes, and the relationships links or edges. The possible values of these nodes, the states, are discrete such as “sandy” or “narrow”. Therefore, discrete variables like sex (male/female/diverse) can be used and continuous variables like buffer width have to be discretized, i.e. the range of possible values has to be cut into classes (e.g. narrow buffer width = 1-10m, wide buffer width = 10-30m).

“Bayesian” means that variables don’t have a unique value (e.g. sex = diverse or buffer width = narrow). Instead, the states of a variable have a specific probability. In the example below (Fig. 1), the probability of buffer width being in the range between 10-30m, and hence considered wide, is 90%. The probabilities of all states of a node sum up to 100%, and hence the probability of the state “narrow” of the node buffer width must be 10%.

The probabilities of the states of a variable (child node) depending on other variables (called parent nodes) are defined in so called conditional probability tables. In the example below, the child node “sediment retention” is linked to (i.e. depends on) the parent nodes “soil texture” and “riparian buffer width”. According to the conditional probability table, if buffer width is wide to 100% and soil texture sandy to 100%, there is a 95% probability that sediment retention is high and 5% probability that sediment retention is low. A mathematical rule called Bayes’ theorem can be used to calculate the probabilities of the states of the child node if the states of the parent nodes have some uncertainty, i.e. if the probabilities are split between states (e.g. only 90% probability for buffer width being wide).

BBNs can also be used inversely to assess the most likely explanation for a given observation: If the sediment retention is high, then the combination of the states of the parent nodes “sandy soils” and “wide riparian buffers” is more likely than other combination of states.

BBNs can deal with incomplete and uncertain knowledge since they are using probabilities, can integrate quantitative data, qualitative data, and expert judgement, and can provide information on causes from evidence – which makes them so useful and flexible.

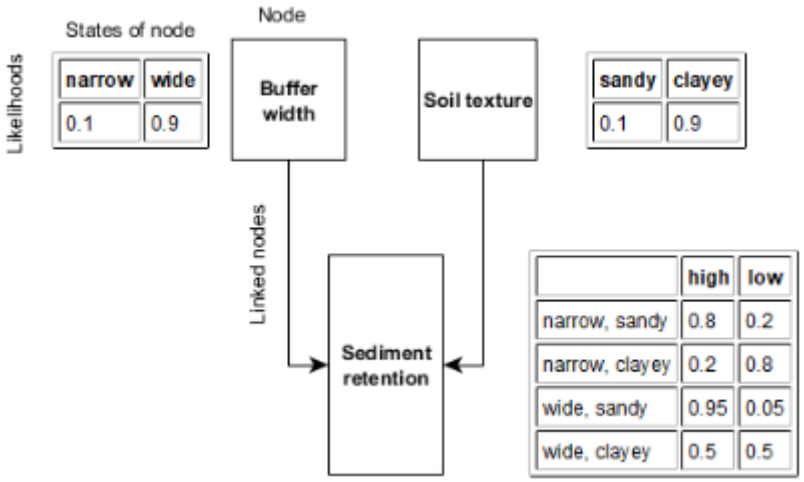

Figure 1: Nodes of a hypothetical BBN to assess the retention of sediment in riparian buffers (child node) based on buffer width and soil texture (parent nodes). The tables give the initial probabilities of the parent nodes and the conditional probabilities of the child node.