An Introduction to
MENTAL MODELER:
A tool for environmental planning and research

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1.0   Overview of Mental Modeler

Mental Modeler is a decision-support software intended to help individuals and communities understand the impacts associated with environmental change and develop mitigation strategies to reduce unwanted outcomes by capturing, communicating and representing knowledge. Through a multi-step process based in Fuzzy-logic Cognitive Mapping (FCM), *Mental Modeler* allows groups of stakeholders to come together and easily develop semi-quantitative models of environmental issues which: (1) define the important components relevant to a community, (2) define the strength of relationships between these components and (3) run "what if" scenarios on these models to determine how the system might react under a range of possible conditions. Through iterative modeling, *Mental Modeler* was developed to help stakeholders' pool and represent collective knowledge and test ideas about their assumptions in "real time" workshop sessions.

Modeling Interface

Mental Modeler is comprised of three main user interfaces: (a) the concept mapping interface that provides a space for model building and parameterizes model construction in the format required for FCM analysis; (b) the matrix interface that allows the structural properties of the cognitive map (i.e. a representation of a mental model or group knowledge) to become clear by examining pairwise relationships; and (c) the scenario interface which allows stakeholders to run and compare change within the system under different potential scenarios and revisit and revise their models in the concept mapping interface in light of this new information.

Once the program is open, indicate whether you would like to Import a Model using an existing Mental Modeler file (.mmp file) or whether you would like to Create a New Model (see Figure 1). This Dashboard view also allows you to track the models you have open using the space to the left (see My Models and Online Models).
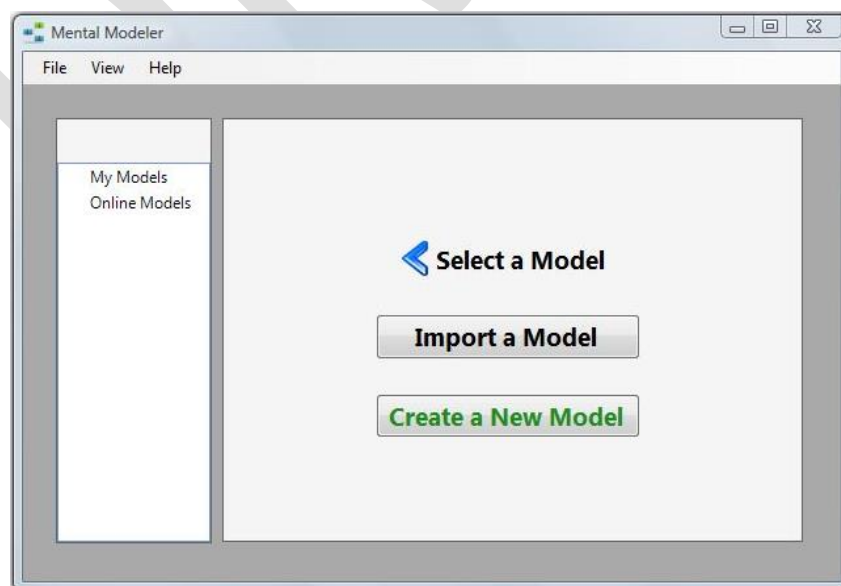

Figure 1. Dashboard will immediately open when starting the software

To Create a New Model, you must first save the model by defining the model's author, model name and you may also include a brief description (see Figure 2). Once the model is saved, the model will be available in the My Models section to the left of the screen.
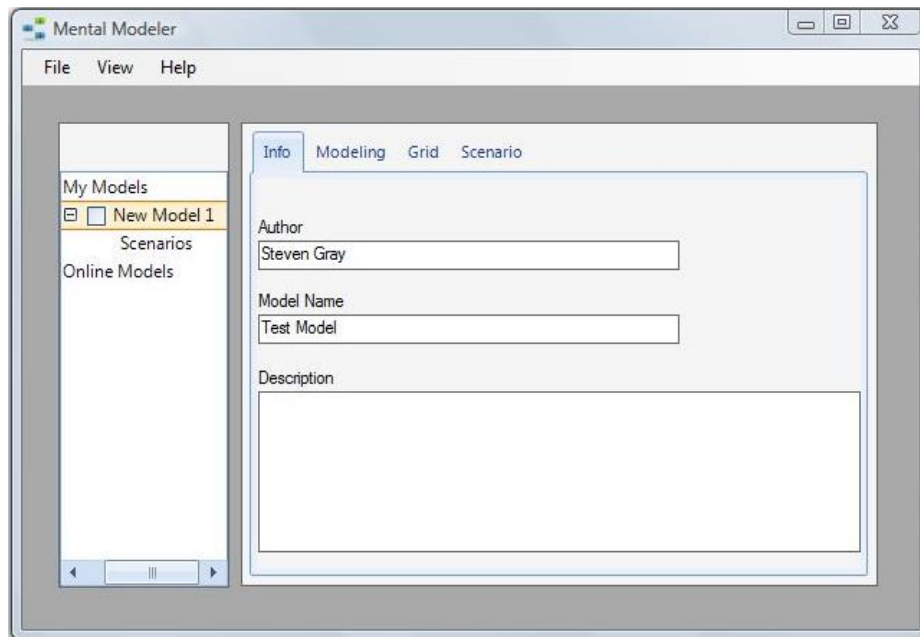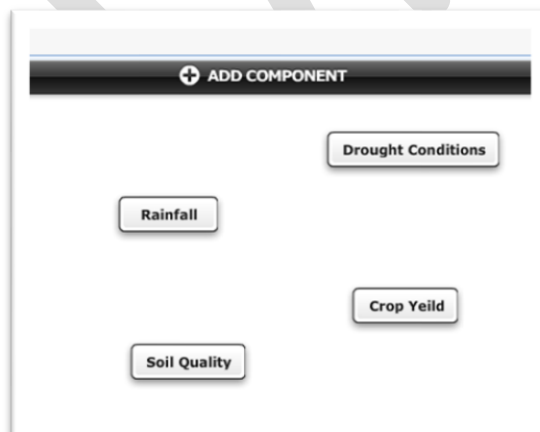

Figure 2. You must save a new model before developing the concept map

1.1. Concept Mapping (Modeling) Tab

The concept mapping interface allows users to fill a conceptual virtual space with components perceived to comprise natural resource or other social-ecological systems. Software users simply use a "plus sign" to add concepts to be structured into their model. By adding concepts, individuals or groups can begin model development by brainstorming all of the important components hypothesized to comprise the system being modeled (see figure 3). After concepts in the model have been determined the amount of influence one component can have on another, called edge relationships, can be defined. Concepts included in the model can have positive (high, medium, or low), negative (high, medium, or low) or no (no relationship defined) edge relationships with one another. The software is developed to parameterize the qualitative relationships (perceived by individuals or groups) between components to be bounded in a manner required for quantitative analyses. The qualitative weights of edge relationships (i.e. "fuzzy" approximation of influence) between components are then translated into the quantitative values between -1 (high negative) to 1 (high positive) values used in the matrix interface (figure 2) represented by high positive (+++), medium positive (++), low positive (+) or high negative (---), medium negative (--), low negative (-). Defining the relationships between components can then be used to define the perceived dynamics between the components that comprise the system being modeled (figure 4a and 4b).

Figure 3. To add components by using button at top of screen
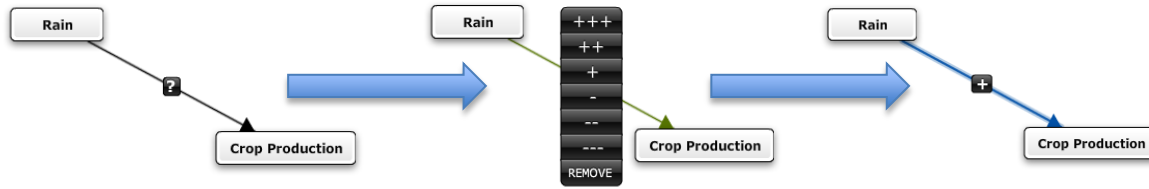
a
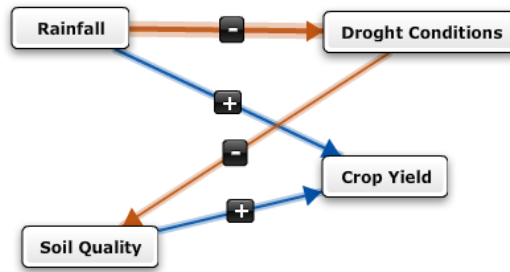
b

Figure 4a and 4b. Moving cursor over the component allows directional relationships to be defined. Clicking on the "?" on the line allows degree of influence between components to be defined in qualitative terms (a). After relationships and values are defined, thickness and color (orange and blue) indicate type and degree of influence.

1.2 Matrix (Grid) Tab

Mental Modeler also includes a Matrix Interface that converts the concept map built in the Concept Mapping Interface into a structural matrix (see figure 5). The matrix interface lists all concepts included in the model on the i and j axes and translates the amount and direction of edge relationships defined in the Concept Mapping Interface into quantitative values between +1 and -1. This interface is simply a different representation of the concept map in the form required for matrix algebra calculation needed for the Scenario interface. The Matrix interface can easily be revised based on the original concept map once the users familiarize themselves with the structure of the tool. Any changes made to the matrix version of the model will appear in the Concept Mapping Interface.

Figure 5. Matrix interface translates concept map into matrix format

1.3 Scenario Tab
The third interface for mental modeler is the Scenario Interface where artificial scenarios can be run and compared. The scenario interface indicates the amount of relative change in the components included in the model based on the edge relationships defined in the Concept Mapping Interface under the scenario chosen. Users can decide what scenario to run based on probable, improbable, gradual and extreme changes to the system. To run a scenario, each variable can be set at a value between H+ (strong negative change in a component) and H- (strong positive change in component). Relative change in the system is displayed as a bar graph to indicate how components might react under a given scenario.

To run scenarios select File>New>Scenario and a new scenario will be added to your model. Name the scenario and change the components values as desired, then select "Refresh Scenario". The degree of relative change to each component under the scenario will appear in the scenario bar chart space (Figure 6).
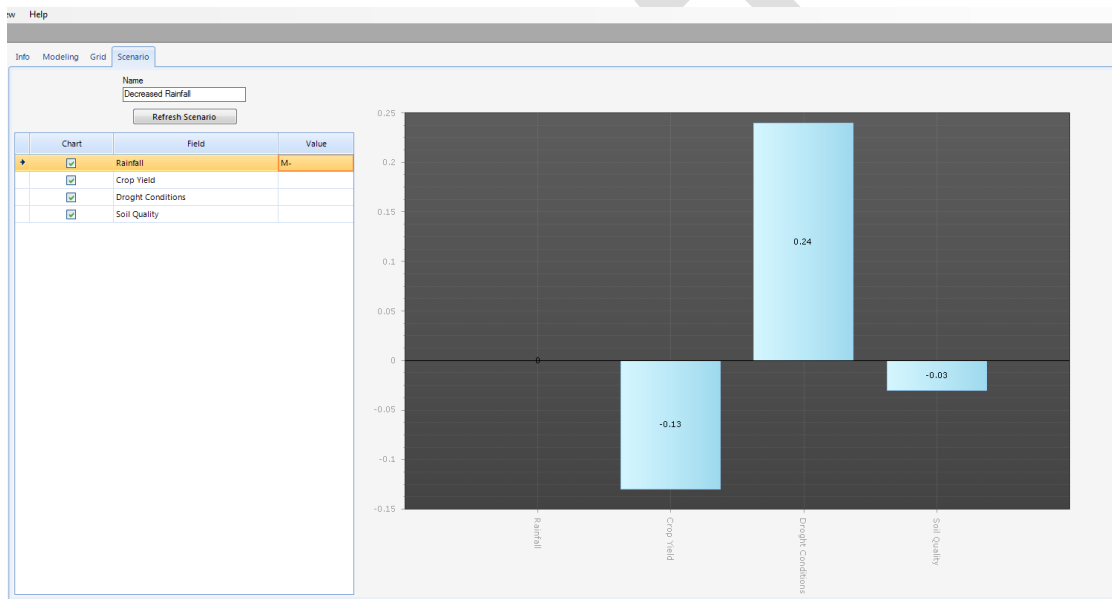

Figure 6. Scenarios can run by selecting File>New>Scenario. Bars indicate degree of relative change in a component under that scenario.

Mental Model Structural Measurement	Description of Measure and Cognitive Inference
N (Concepts)	Number of variables included in model; higher number of concepts indicates more components in the mental model (Özesmi and Özesmi 2004)
N (Connections)	Number of connections included between variables; higher number of connections indicates higher degree of interaction between components in a mental model (Özesmi and Özesmi 2004)
N (Transmitter)	Components which only have "forcing" functions; indicates number of components that effect other system components but are not affected by others (Eden et al.1992)
N (Receiver)	Components which have only receiving functions; indicates the number of components that are affected by other system components but have no effect (Eden et al.1992)
N (Ordinary)	Components with both transmitting and receiving functions; indicates the number of concepts that influence and are influenced by other concepts (Eden et al.1992)
Centrality	Absolute value of either (a) overall influence in the model (all + and – relationships indicated, for entire model) or (b) influence of individual concepts as indicated by positive (+) or negative (-) values placed on connections between components; indicates (a) the total influence (positive and negative) to be in the system or (b) the conceptual weight/importance of individual concepts (Kosko 1986a). The higher the value, the greater is the importance of all concepts or the individual weight of a concept in the overall model
C/N	Number of connections divided by number of variables (concepts). The lower the C/N score, the higher the degree of connectedness in a system (Özesmi and Özesmi 2004)
Complexity	Ratio of receiver variables to transmitter variables. Indicates the degree of resolution and is a measure of the degree to which outcomes of driving forces are considered. Higher complexity indicates more complex systems thinking (Eden et al.1992; Özesmi and Özesmi 2004)
Density	Number of connections compared to number of all possible connections. The higher the density, the more potential management polices exist (Özesmi and Özesmi 2004; Hage and Harary 1983)
Hierarchy Index	Index developed to indicate hierarchical to democratic view of the system. On a scale of 0-1, indicates the degree of top-down down (score 1) or democratic perception (score 0) of the mental model (McDonald 1983)