The Future of Bayesian Network Modelling

Advances in Integrated Modelling Technologies with Bayesian Networks

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BN modeling is useful for:

- data mining
- causal modeling
- representing expert knowledge
- combining expert knowledge and empirical data
- identifying key uncertainties
- much more !

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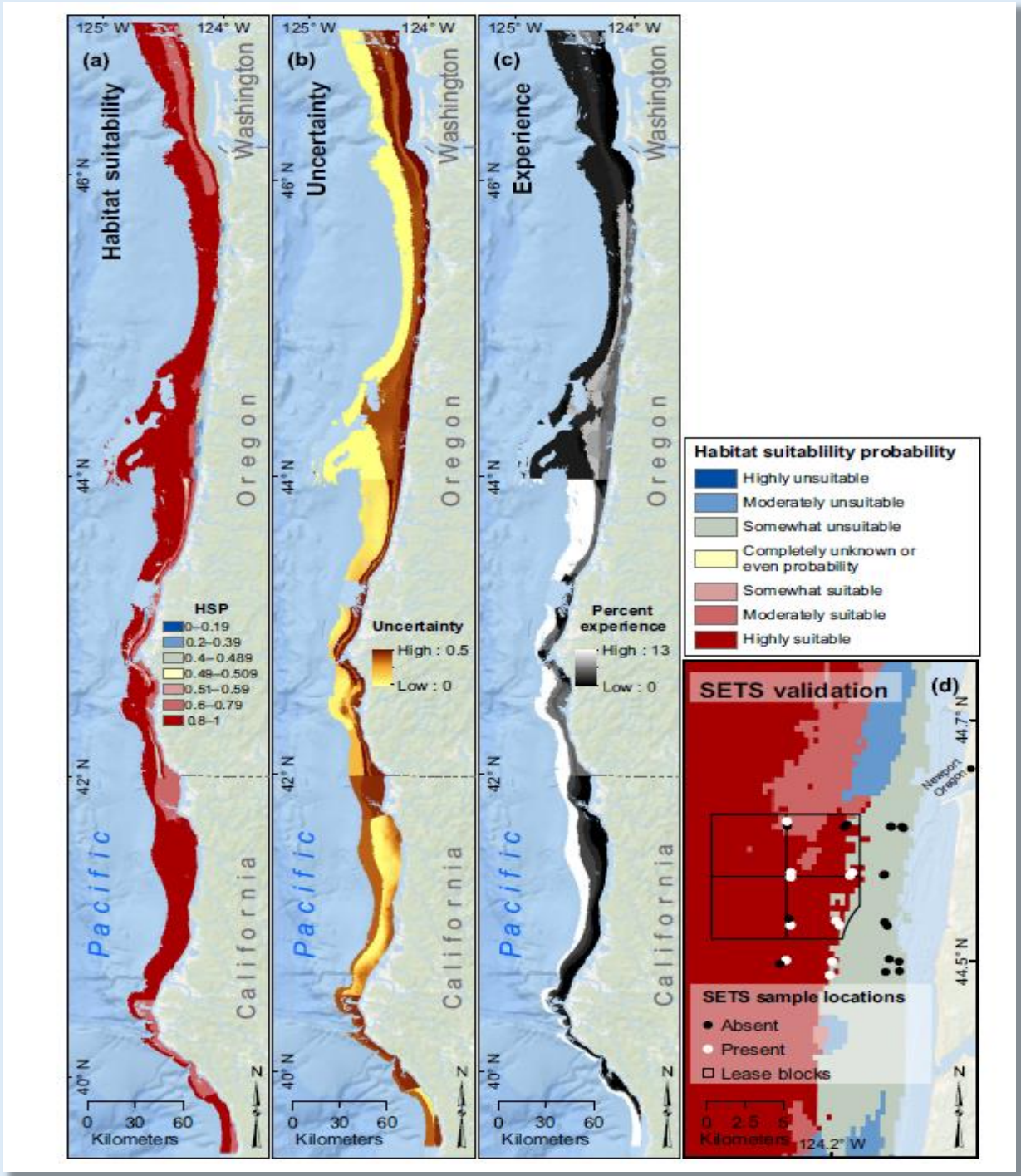
BNs provide a highly flexible network structure, lending to integration with other modeling technologies and approaches

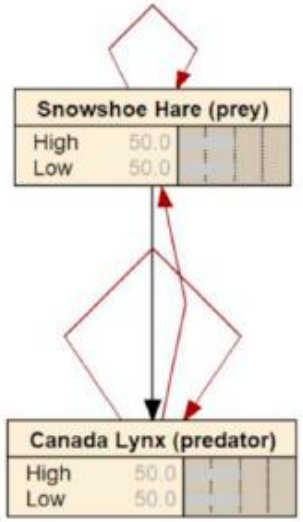
Geographic Information Systems – GIS BNs



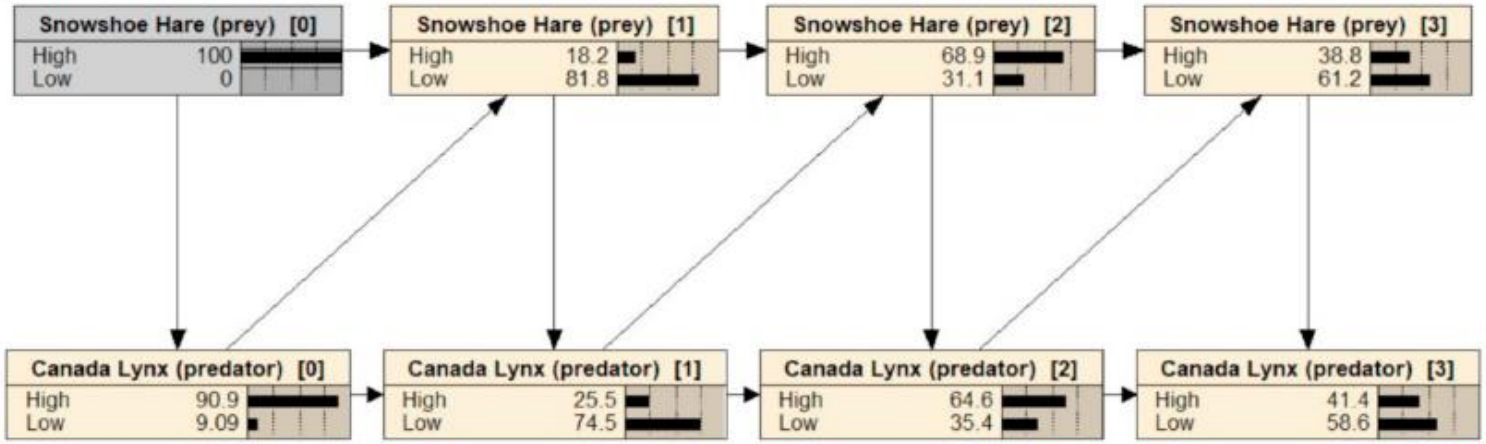
Havron et al., B. G., and T. D. Penman, 2017, Ecosphere 8(7):e01859

Dynamic Bayesian Networks - DBNs

(a)

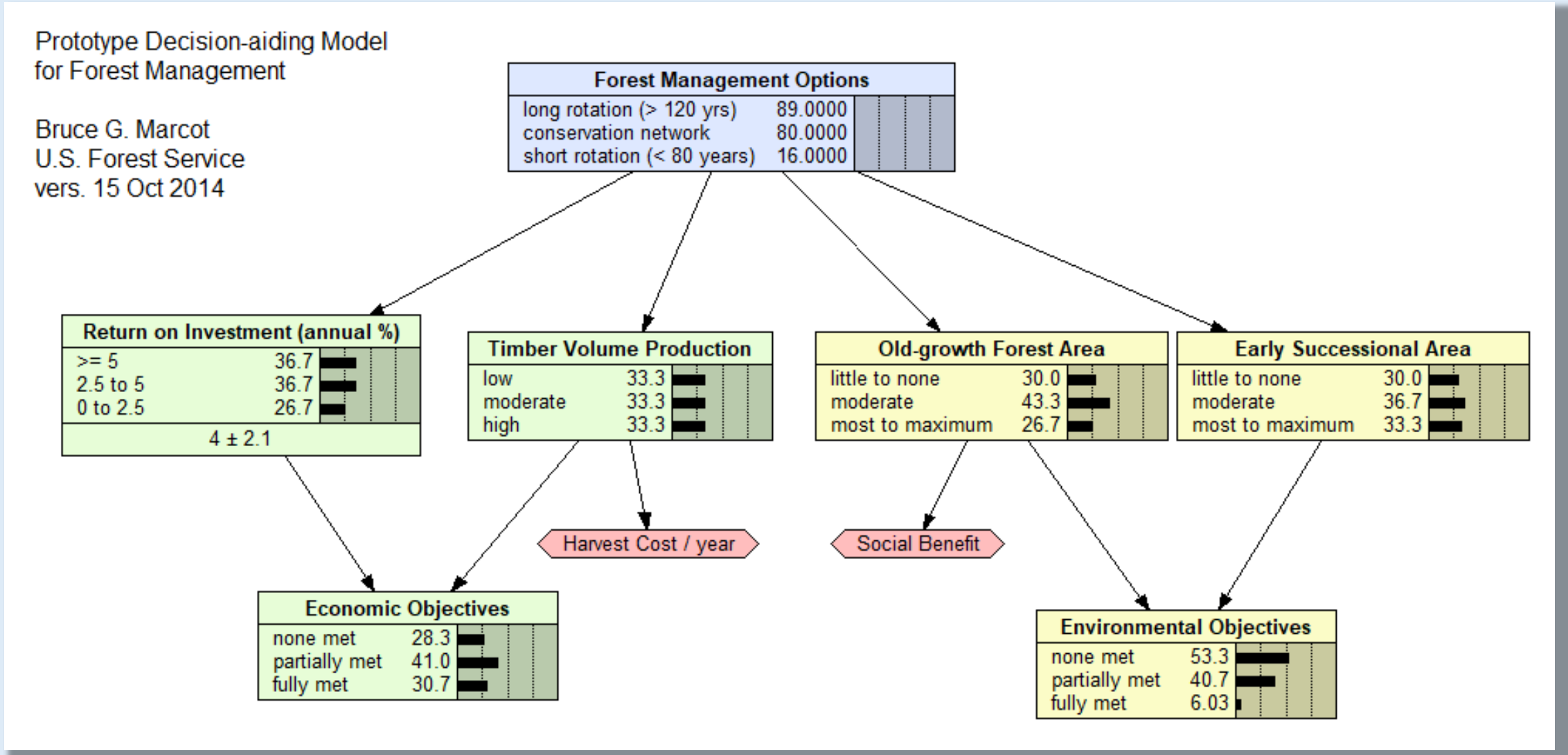


(b)



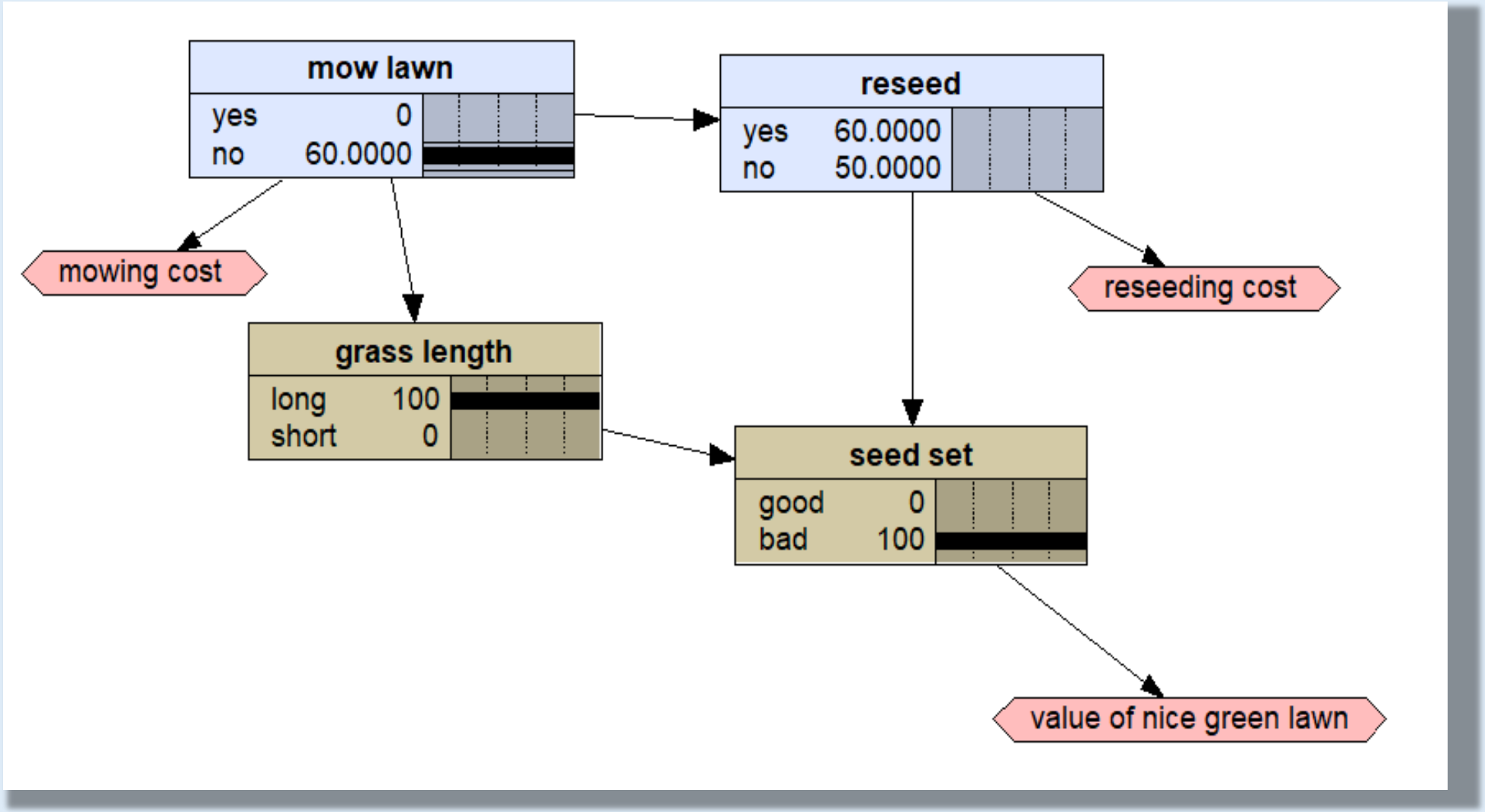
Marcot & Penman, 2019, Environ. Mod. & Softw. 111:386-393.

Bayesian Decision Networks - BDNs



Marcot, unpub.

Dynamic Decision Networks - DDNs



Unpub.

Structural Equation Modeling - SEM

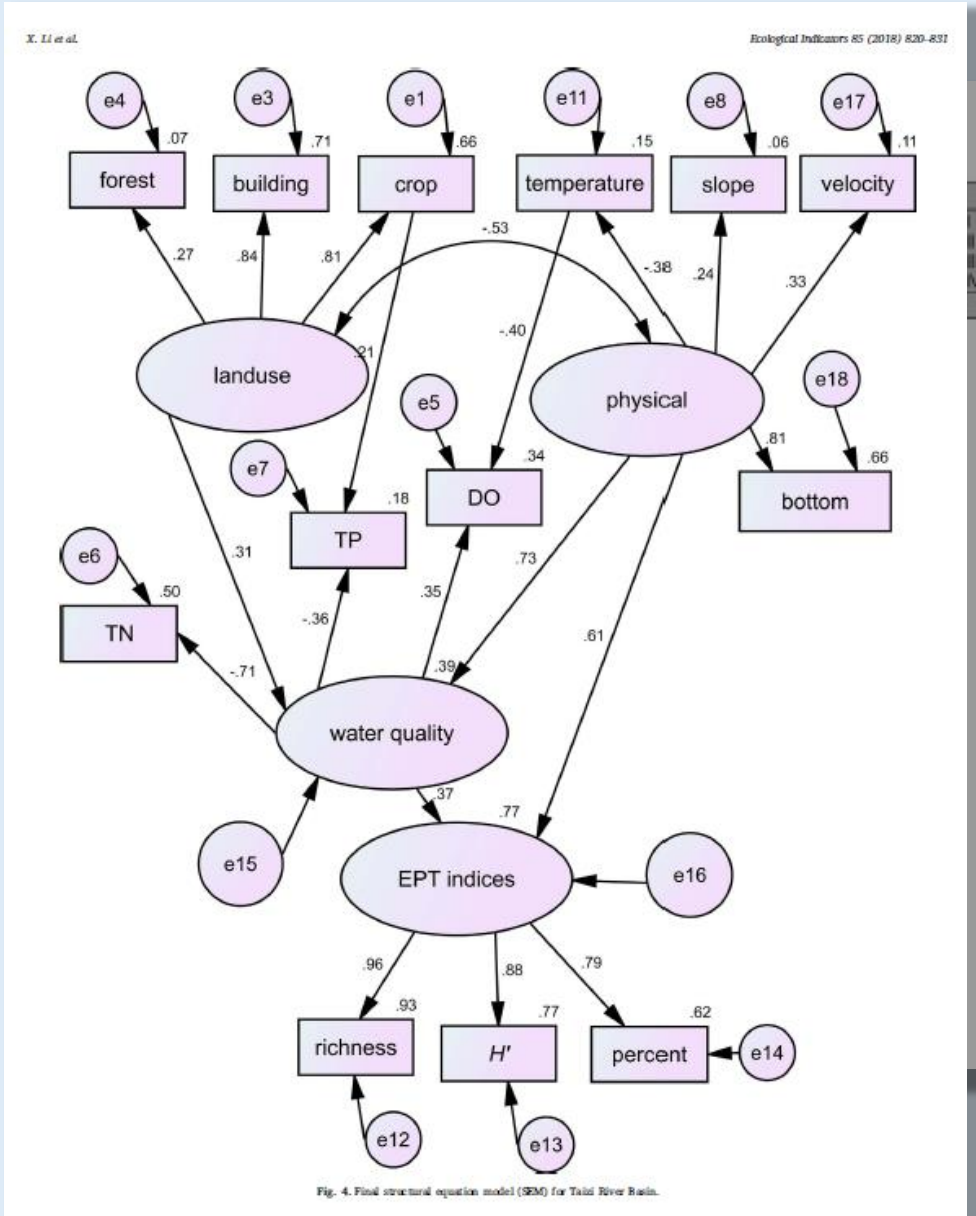


Fig. 4. Final structural equation model (SEM) for Taizi River Basin.

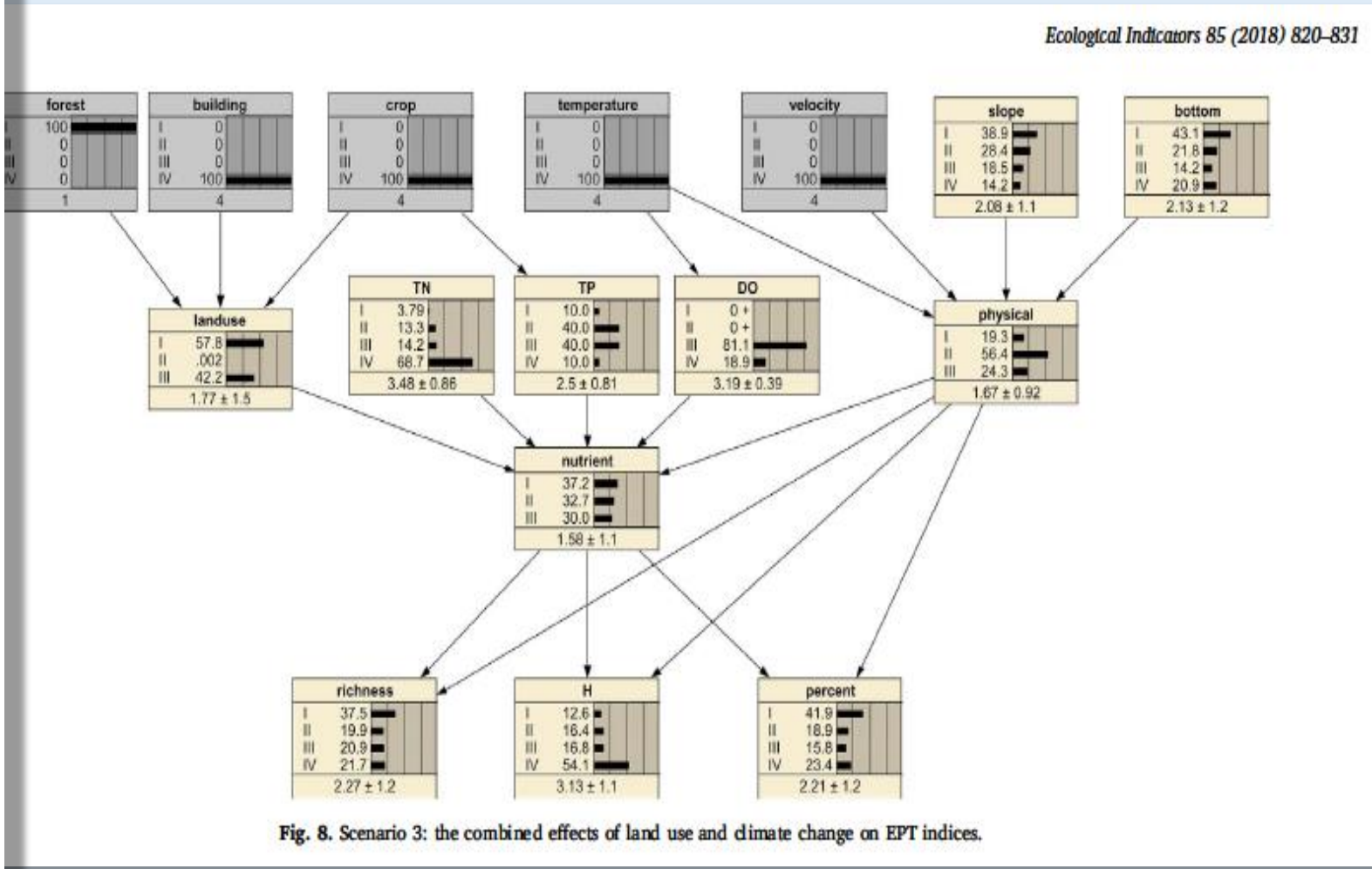


Fig. 8. Scenario 3: the combined effects of land use and climate change on EPT indices.

Li et al., 2018, Ecol. Indic. 85:820-831.

Bayesian Neural Networks

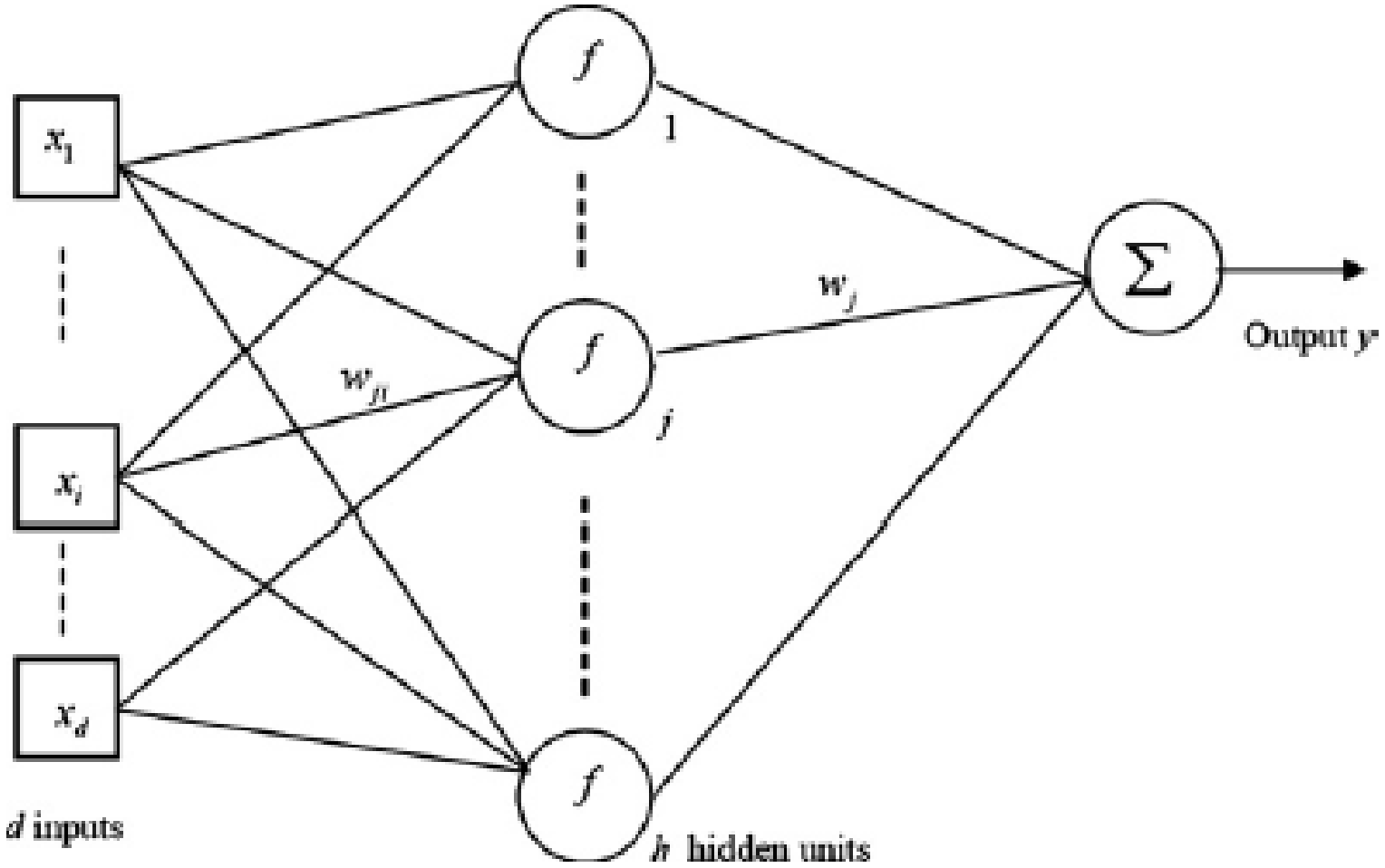
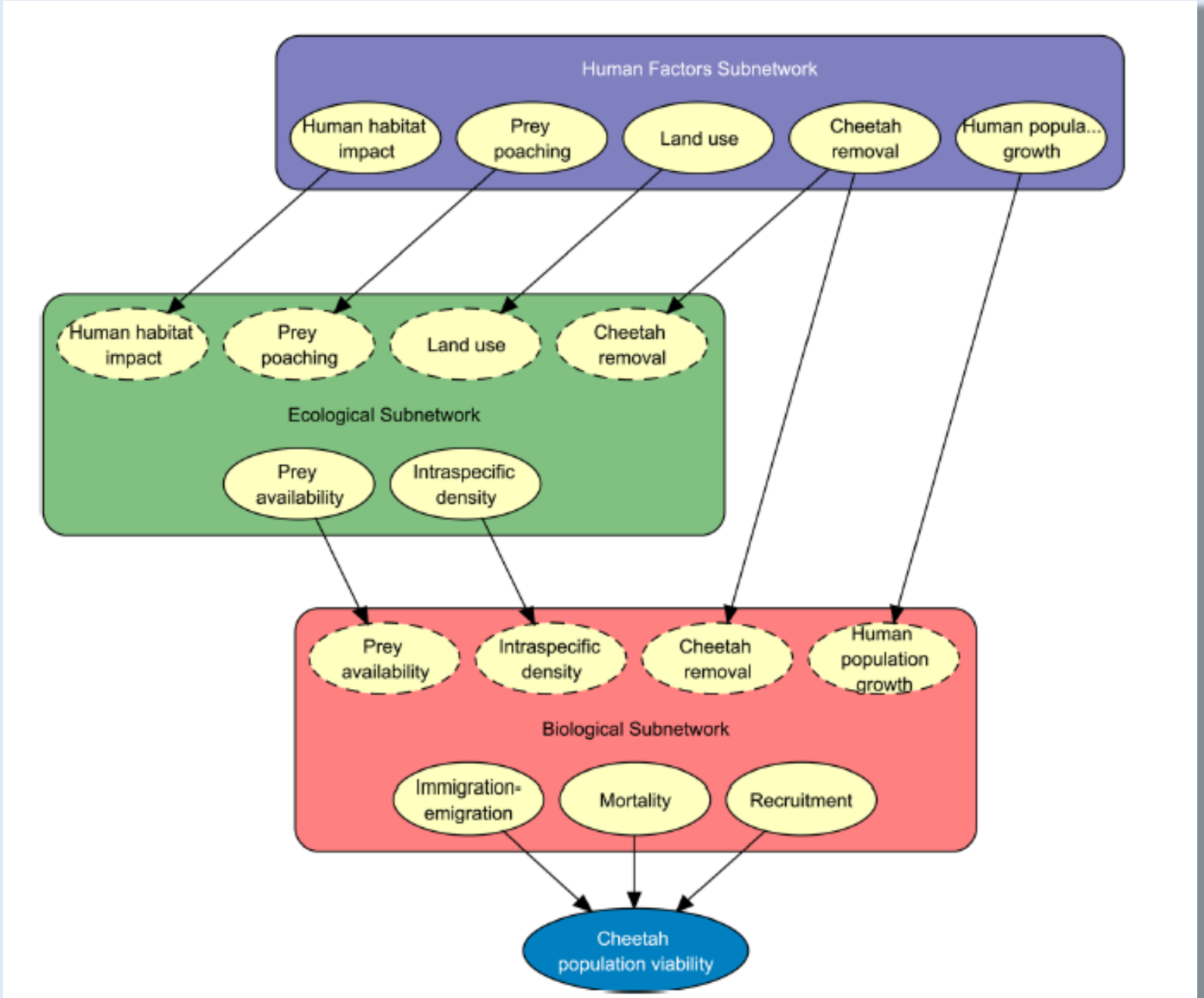


Fig. 1. Sketch of a MLP with d inputs and h hidden units, in our case, $d = 14$ (see Table 1). The output y is the next day's load at the same hour.

Lauret et al., 2008, Energ. Convers. & Mgmt 49(5):1156-1166.



Object-Oriented Bayesian Networks - OOBNs

Johnson et al., 2013, Ecosphere 4(7):DOI: 10.1890/ES12-00357.1

Agent-based Bayesian Networks

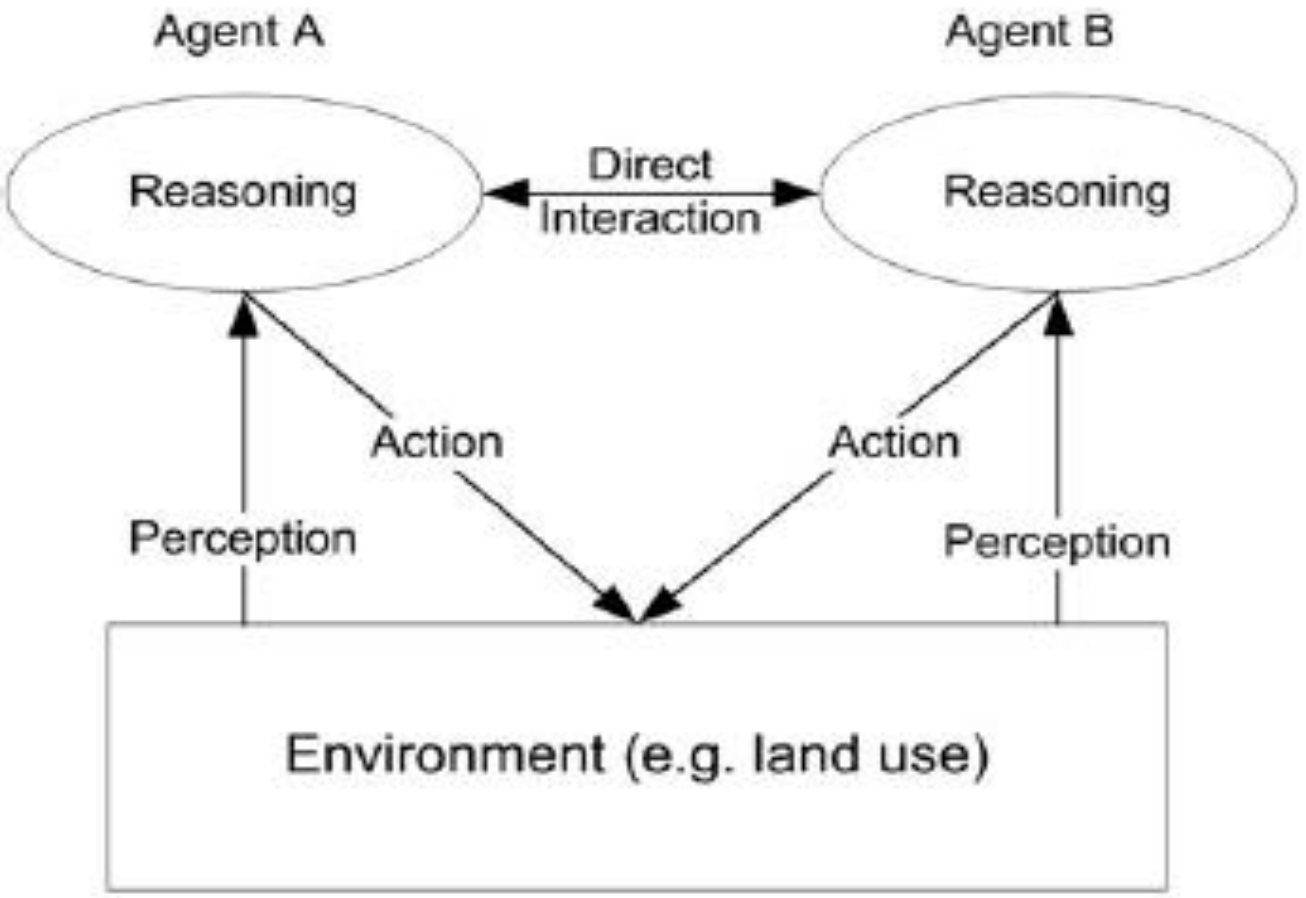
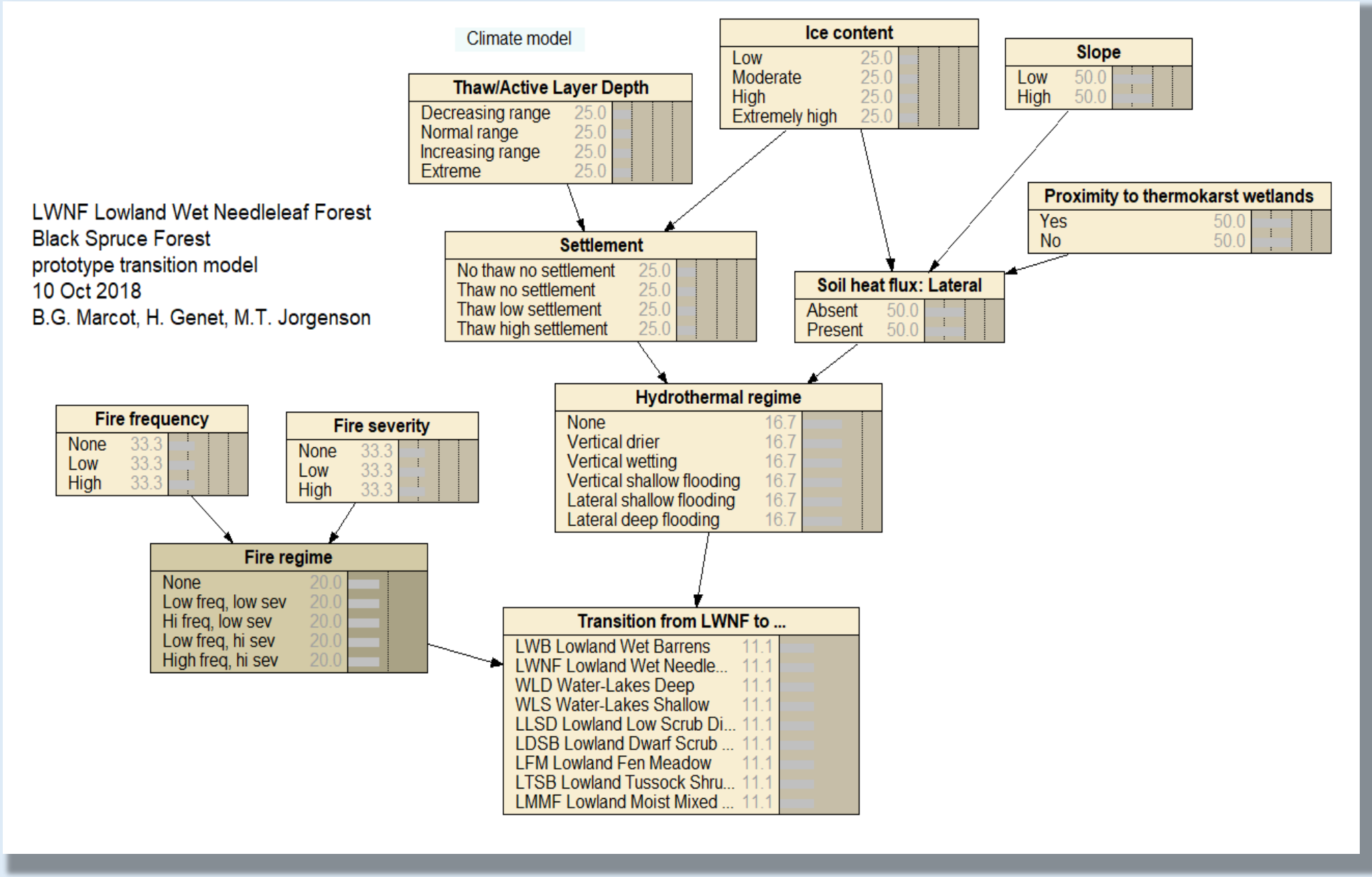


Fig. 5. Direct and indirect interactions among agents. Source: Adapted from Janssen and Ostrom (2006).

Sun & Müller, 2013, Env. Model. & Softw. 45:15-28.

State-and-transition Bayesian Networks - STM-BNs

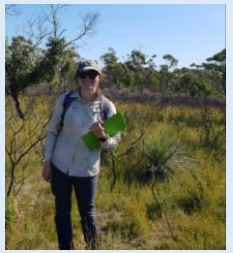


Marcot, unpub.

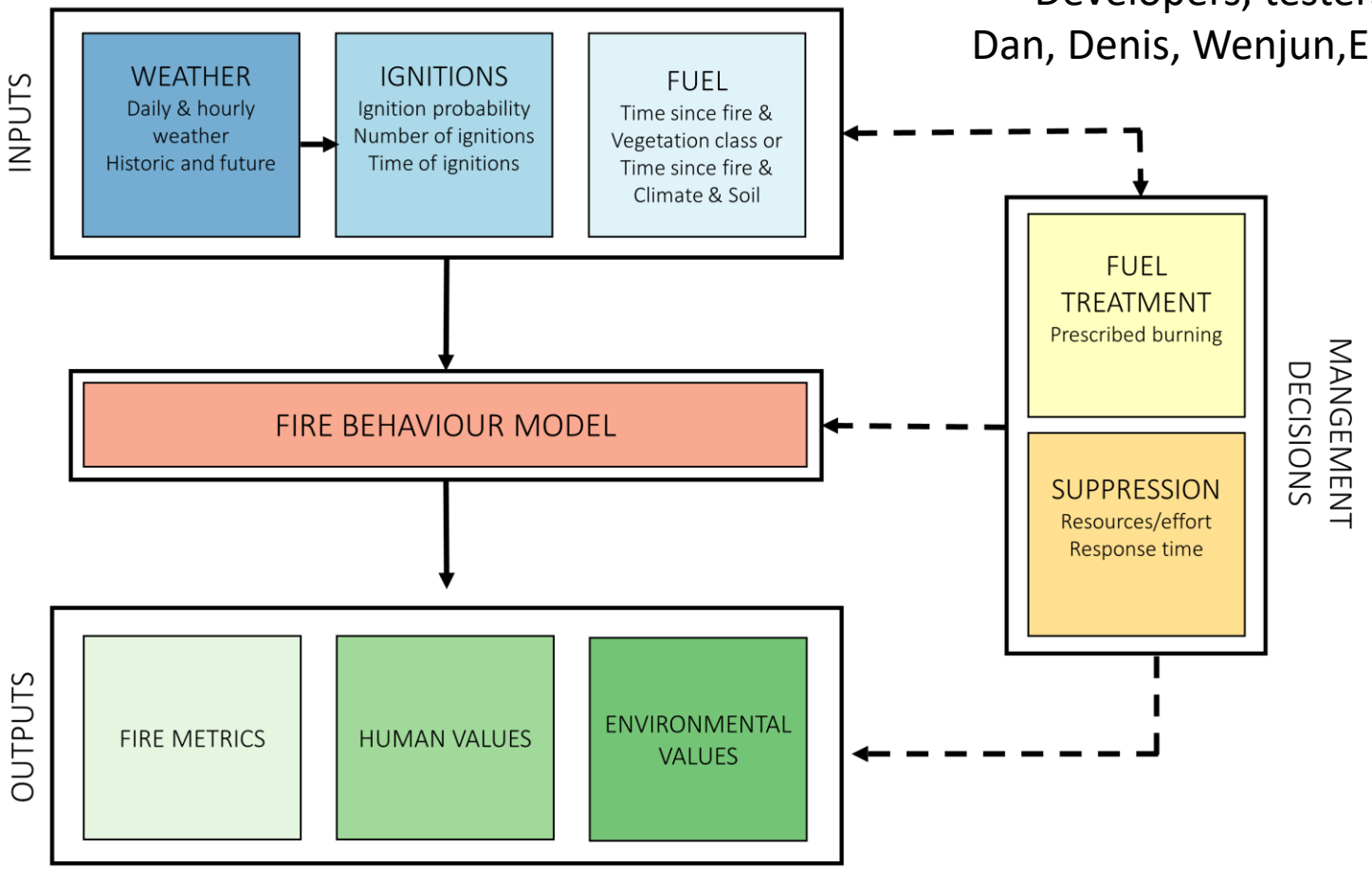
BNs Within Things!







Developers, testers, appliers:
Dan, Denis, Wenjun,Erica and Sarah



McColl-Gausden et al., 2022, Global Climate Change Biol. 28:5211-5226.

Riparian Habitat (r)

present $0.3162\ e^{i\theta(r=true)}$

absent $0.9487\ e^{i\theta(r=false)}$

Low-lying Acacia Woodland, Thorn Scrub, Savanna (w)

present $0.8367\ e^{i\theta(w=true)}$

absent $0.5477\ e^{i\theta(w=false)}$

Riparian	Woodland	Bat Habitat: Good	Bat Habitat: Poor
present	present	$0.9487\ e^{i\theta jt\|wt,rt}$	$0.3162\ e^{i\theta jf\|wt,rt}$
absent	present	$0.8944\ e^{i\theta jt\|wt,rf}$	$0.4472\ e^{i\theta jf\|wt,rf}$
present	absent	$0.8944\ e^{i\theta jt\|wf,rt}$	$0.4472\ e^{i\theta jf\|wf,rt}$
absent	absent	$0.7071\ e^{i\theta jt\|wf,rf}$	$0.7071\ e^{i\theta jf\|wf,rf}$

Figure 4. EcoQBN representation of the occurrence of two environments and their combinations to form quantum conditional probability values of the habitat quality for yellow-winged bats.

Quantum Bayesian Networks - QBNs

Marcot, 2021, Entropy 23(4):441

What's Next … ??

- Real-time applications & updating ?
- Crowd-sourced BNs ?
- Big Data BNs ?
- Self-organizing BNs ?

Where … to … next ??

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