

How to address the complexity of environmental risk assessment? – calling for a modular approach instead of large black box models



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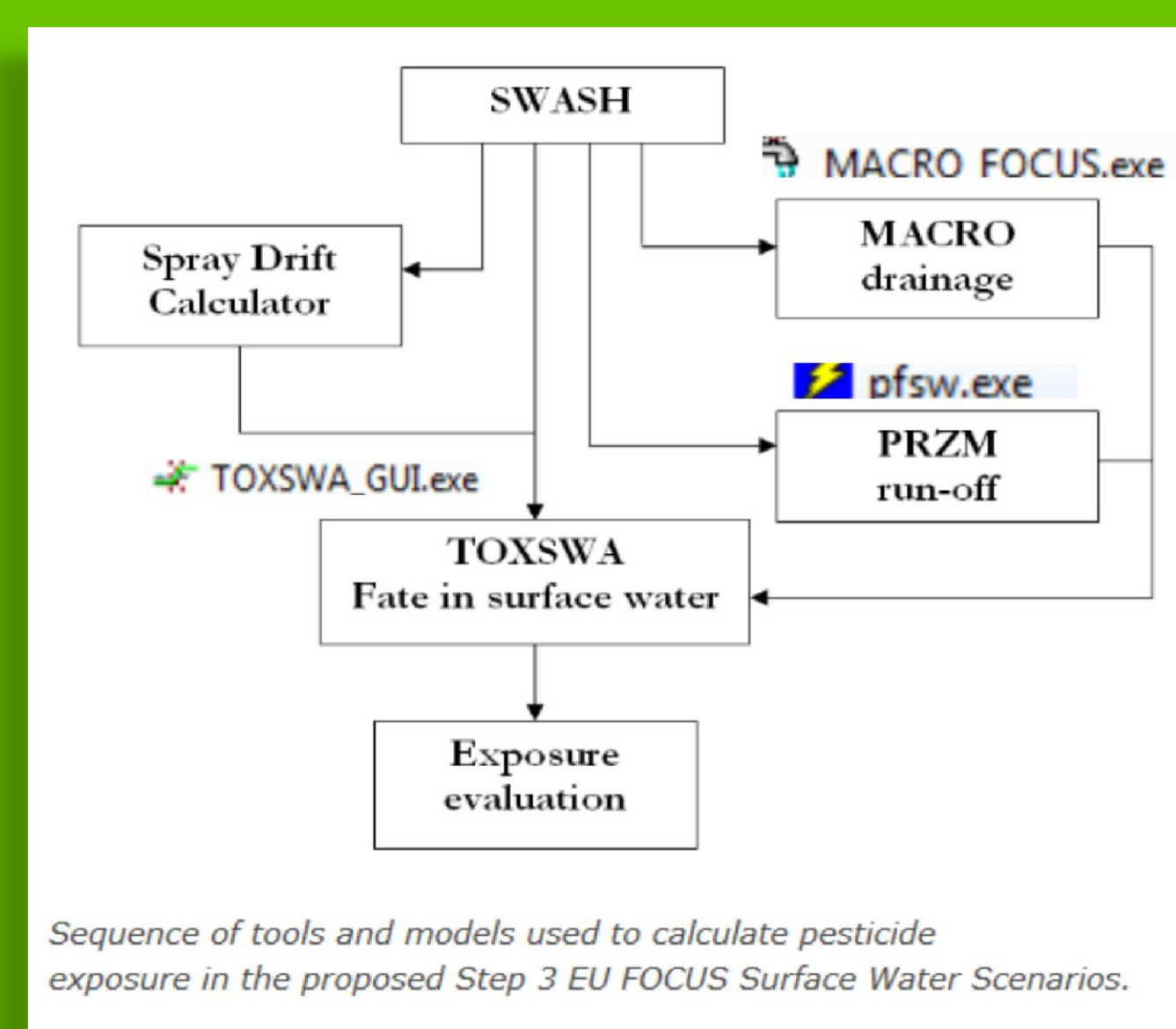
Current Approach:

- Current model developments are often very detailed in the aspect of their primary interest whereas other processes are simplified, lumped together or even ignored.
- On the other hand complex black box models get in transparent by historic growth and increasing size of source code and come with an overwhelming complexity which cannot be fully evaluated by single experts. This automatically increases the mistrust and ambiguity in using these complex models.

Thesis:

- All models needed for environmental risk assessment could be built from a set of standardized more or less generic building blocks which would lead to a modular model development.
- Then, model development and model testing (validation) can be conducted first on specific modules by experts in their field.
- This would allow experts to agree on a module in their field of expertise and later on it has only to be assessed whether different modules were assembled properly.

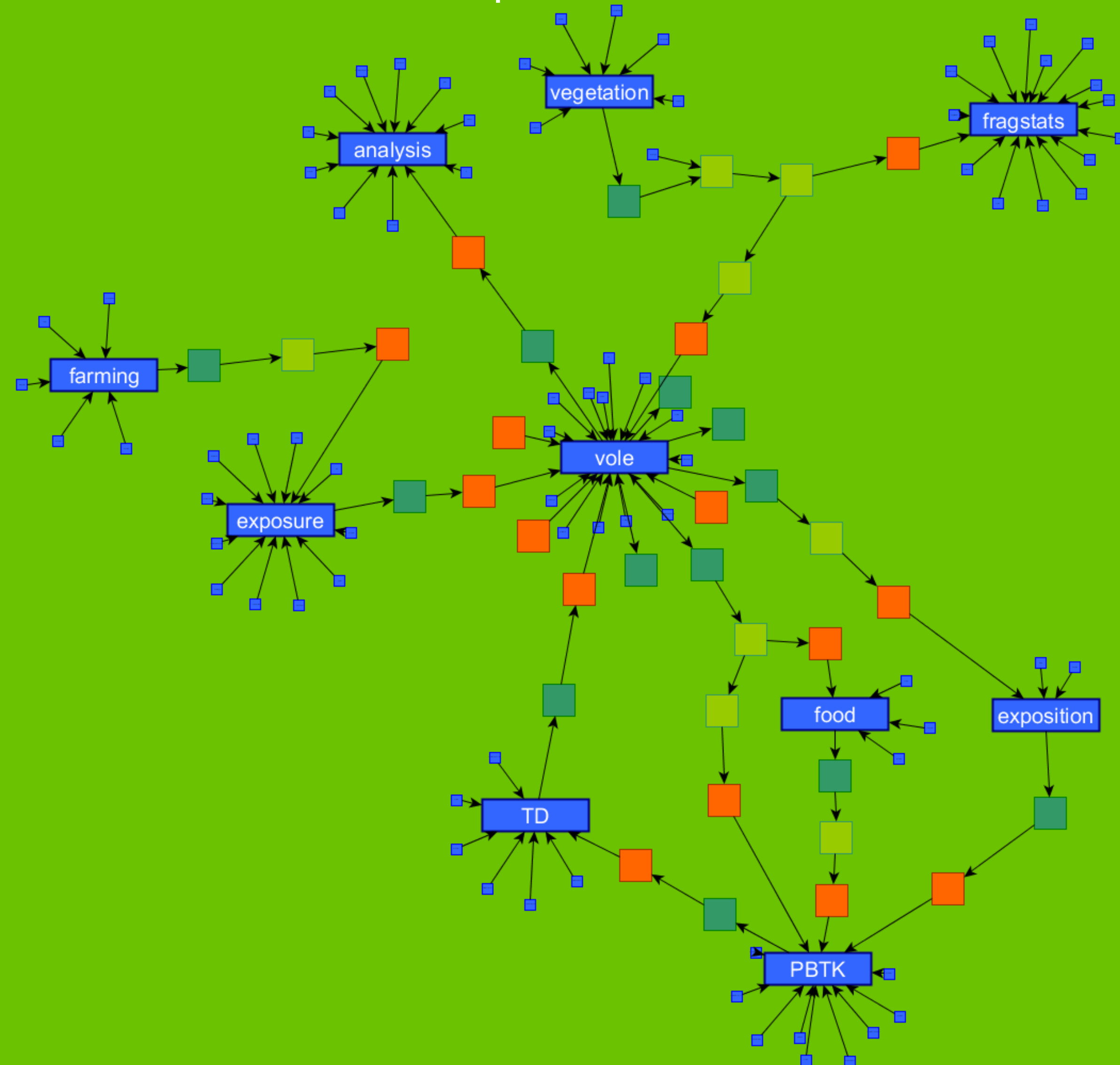
Example I: FOCUS Surface Water Models



→ The regulatory accepted FOCUS surface water model, is not a single model it is a modular model approach

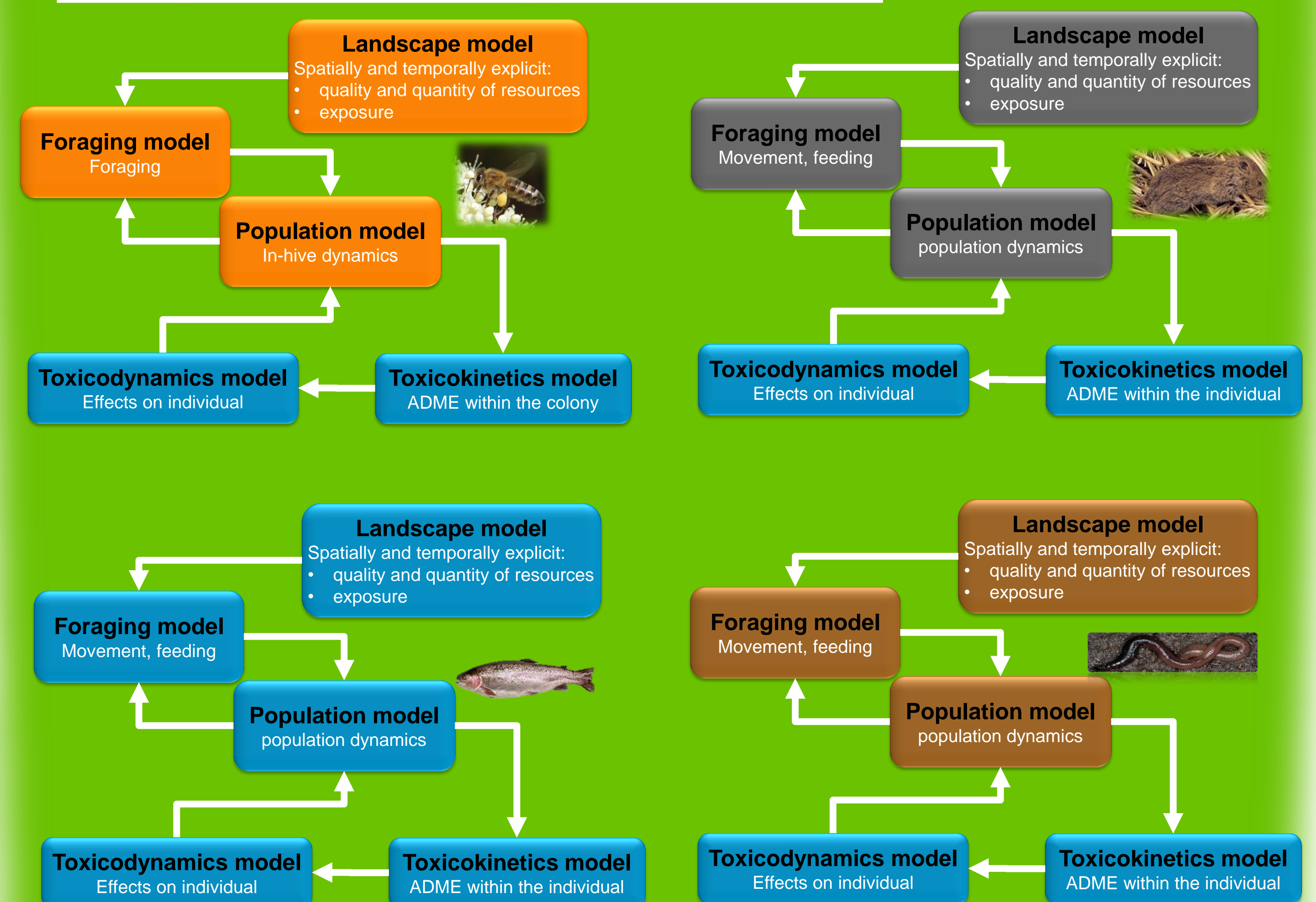
Example III: Open MI

Models from different developers



- Nowadays techniques are available to build modular model approaches in which models from different developers, in different languages can exchange input and outputs in a standardised way in the main memory
- One technique is Open MI www.openmi.org

Example II: Modular approach for ERA



→ From a modeller perspective different risk assessment schemes can be addressed in a standardised way, but need different modules (e.g exposure and habitats are different for fish and vole).

Example IV: Available Modules

	Bee	Vole	Fish	Earthworms
Toxicokinetics	?	Body burden modeling, PBTK	First-order, second-order, PBTK	First-order, second order
Toxicodynamics - lethal	Dose-Response, GUTS			
Toxicodynamics - sublethal	Dose-Response	Dose response, DEBTox		
Population model	BEEHAVE	eVole, Polaris, Almass	IBM	Johnston et al. 2014
Forager model	Baveco 2016, BEESCOUT,...	eVole, Polaris, Almass	IBM	Johnston et al. 2014
Weather	FOCUS Scenarios, EFSA Soil scenarios, MARS Data,...			
Farming practice	Almass, ...			
Crop development	FOCUS Scenarios, Almass, Crop models,...			
Exposure	?	eVole, Polaris, Almass	SWASH	Pelmo, PEARL,...

- A variety of building blocks is already available, examples (no complete list!) given above
- Specific models (e.g. Almass, Polaris) already use generic modules (e.g. dose-response to simulate effects)

Conclusion

- Realistic landscape level risk assessment is complex, building big standalone models increases resource needs and reduce transparency
- Defining modules is a prerequisite to focus on core expertise and to reduce the overall complexity into manageable pieces that reduce workload
- Reusing modules for other risk assessment schemes reduces the needed resources and delivers coherent risk assessments (e.g. PEC_{gw} and PEC_{soil})
- To be applied in different situations the models should be generic and realistic (conservatism has to be in the ecological scenario), what is worst case for ground water may be the best case for soil risk assessment
- Modules can be used in different combinations to answer different questions, e.g. using the GUTS or DEBTox model to address the ecological threshold option and link them to a population model to address the ecological recovery option
- The combined modules appear to the user as a single software that can be administered and maintained with established versioning principles as for FOCUS models