Selection and Evaluation of a Framework for Interoperable Freshwater Modelling

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The motivation

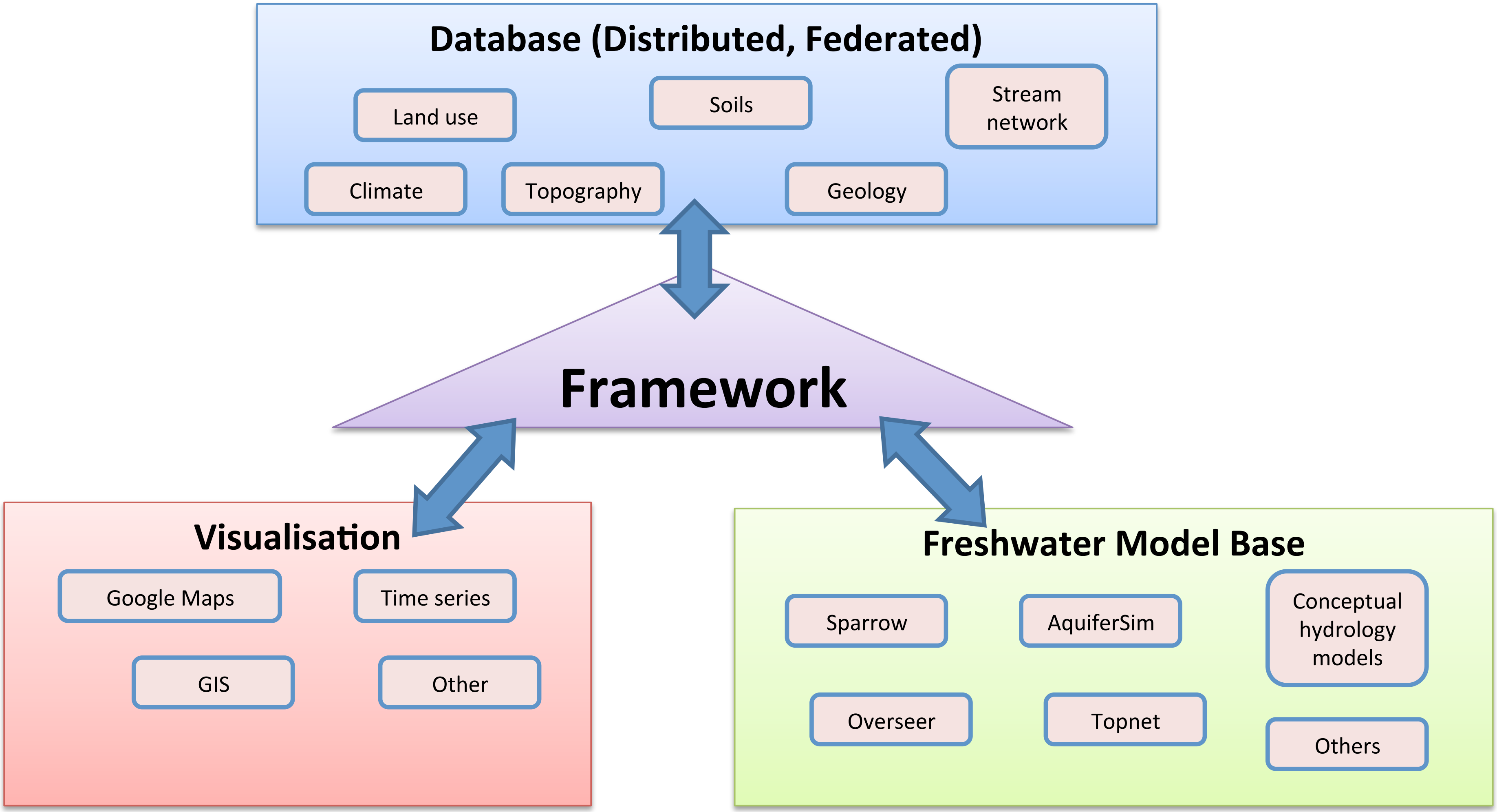
- Better organisation and linking of freshwater models in New Zealand
- Better use of environmental datasets
- *"robust interoperable models to assist the development and implementation of freshwater policy and management" (MfE)*

NIWA
Taihoro Nukurangi

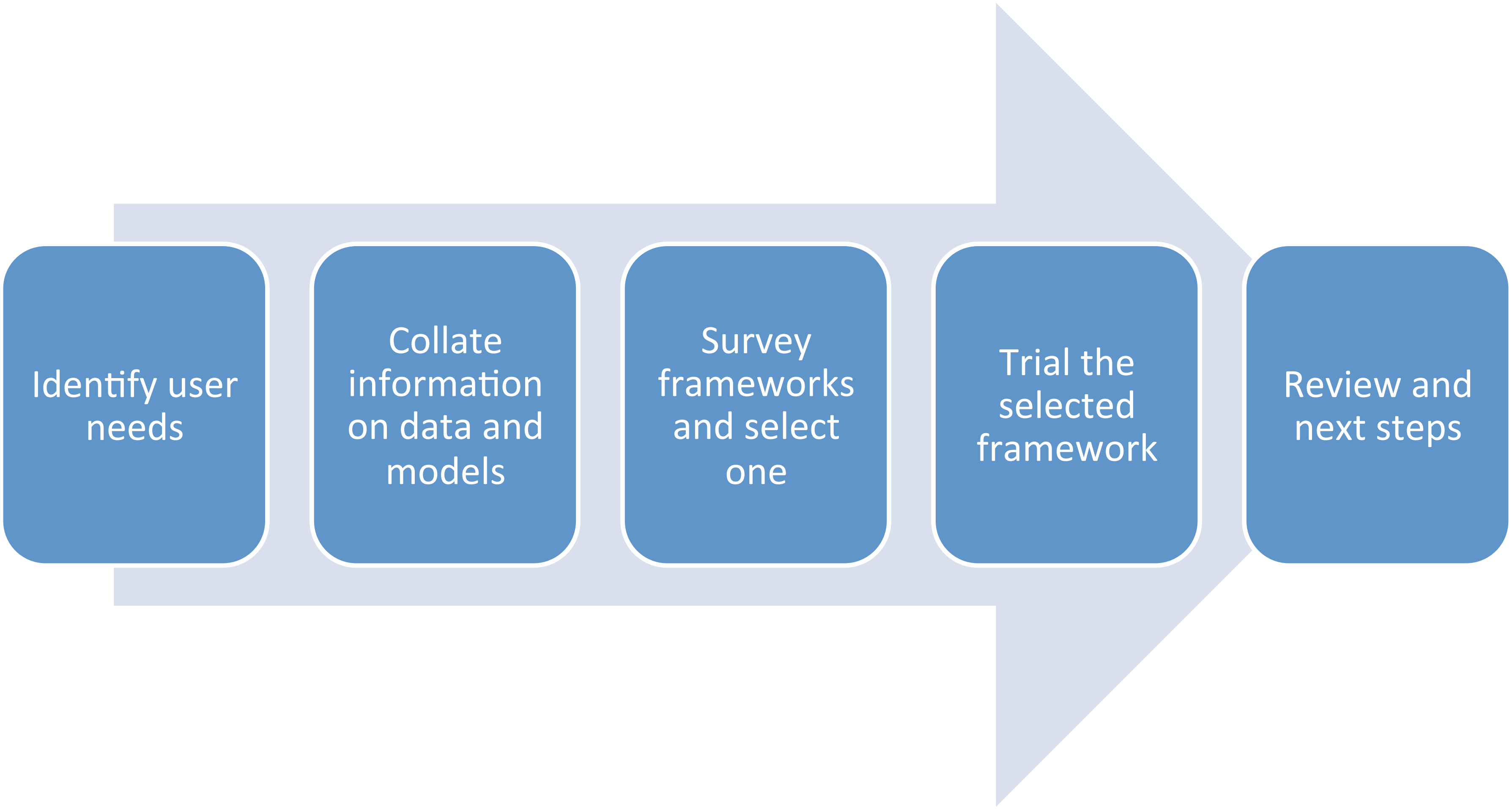
agresearch

Landcare Research
Manaaki Whenua

Our original view of a framework



Stages of our investigations



Identify user needs

Collate information on data and models

Survey frameworks and select one

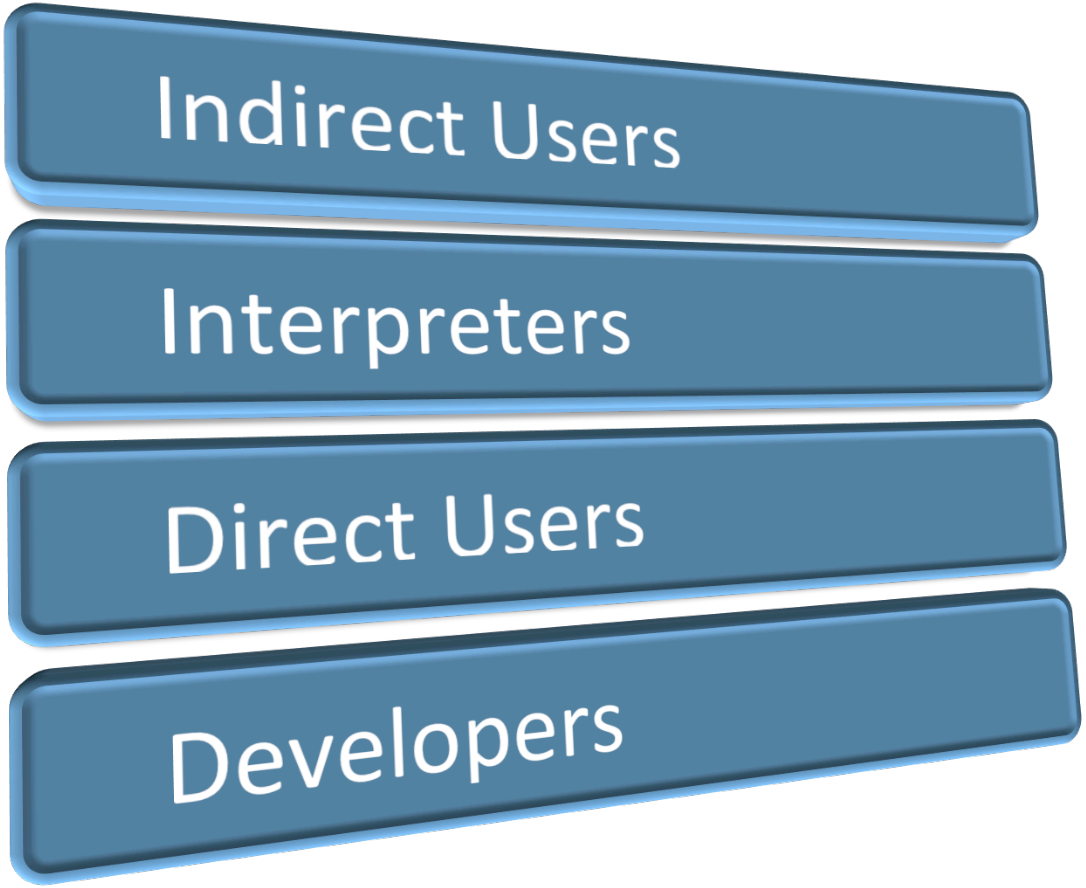
Trial the selected framework

Review and next steps

Expected benefits of a framework (identified in user workshop)

- Efficiency of model use
- More robust model estimates
- Transparency of how models are used
- Better and more timely policy and regulatory decisions
- Decreased costs of model provisioning
- Answer more complex questions

Classes of framework user

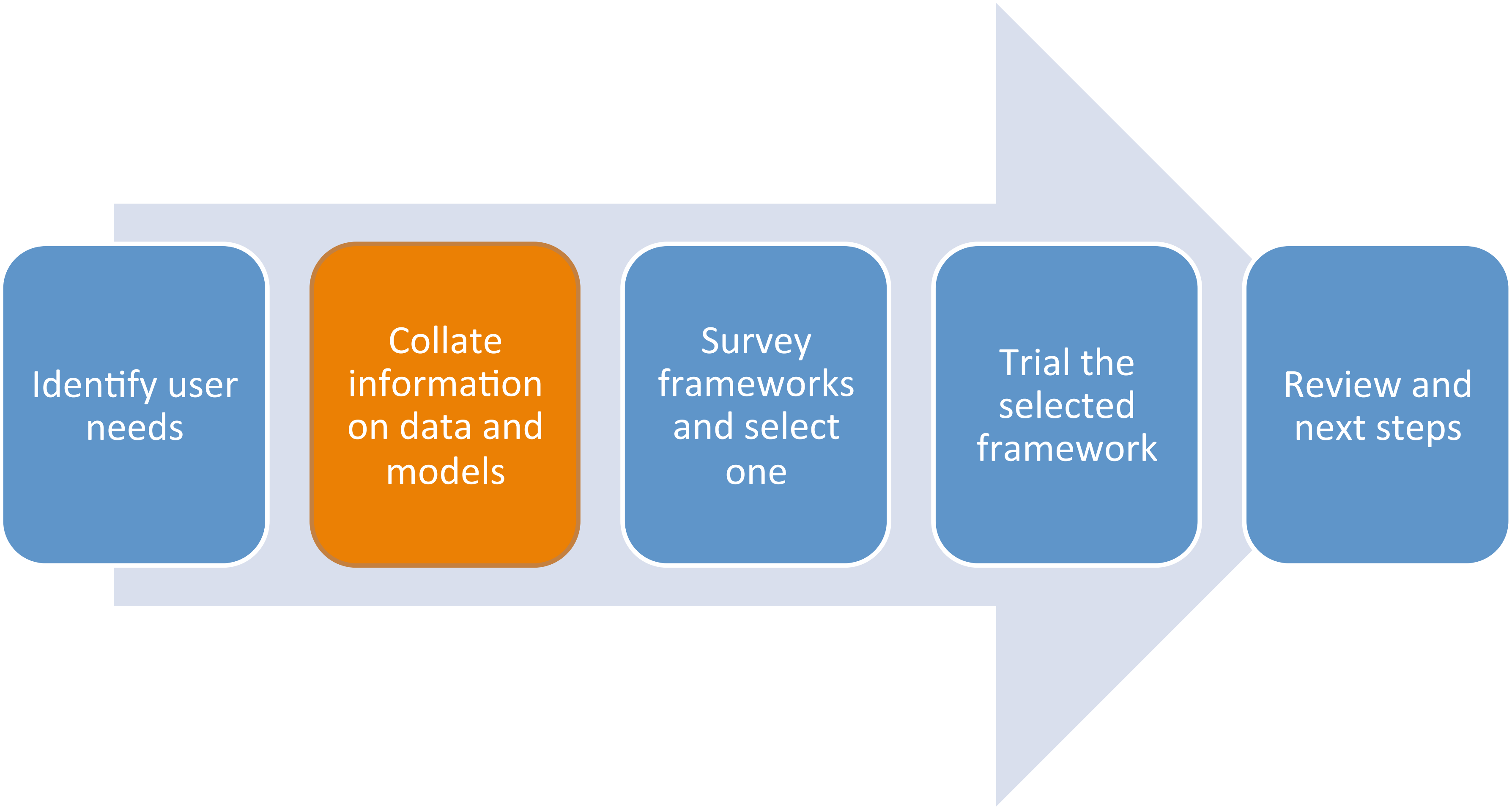


Criteria for framework selection 33 identified, 13 key

Key Criteria

1. Previous model/data/parameter assemblages can stored and re-run
2. Supports dynamic models
3. Supports static models
4. Can add/remove/substitute components, not a fixed assemblage
5. Framework software is open-source and non-proprietary
6. Framework is available for anyone to use at low or nil cost
7. Uses open standards for model interfaces
8. Uses open standards for data
9. Can work at a range of spatial scales
10. Supports spatial models
11. Supports geospatial data
12. Continuity and good prospects of longevity
13. GUI for configuring and setting up models

Stages of our investigations



Wiki with database of models and data

teamwork.niwa.co.nz/display/IFM

Confluence Spaces People Browse Create

Search

Final Report to MBIE
Inventory of Models and ModelVis graphical tool
- **Compilation of models and their attributes**
- Relationships between models - the ModelVis tool
- Other NZ inventories

Frameworks Inventory, Screening and Report
Data for Freshwater Modelling
User Needs Workshop 20 June 2011
IFM Presentation to 2013 NZ Hydrological Society Conference
OMS3 Notes for developers
People in the team
Bits and Pieces

Interoperable Freshwater Models / Framework for Interoperable Freshwater Models / Inventory of Models and ModelVis graphical tool

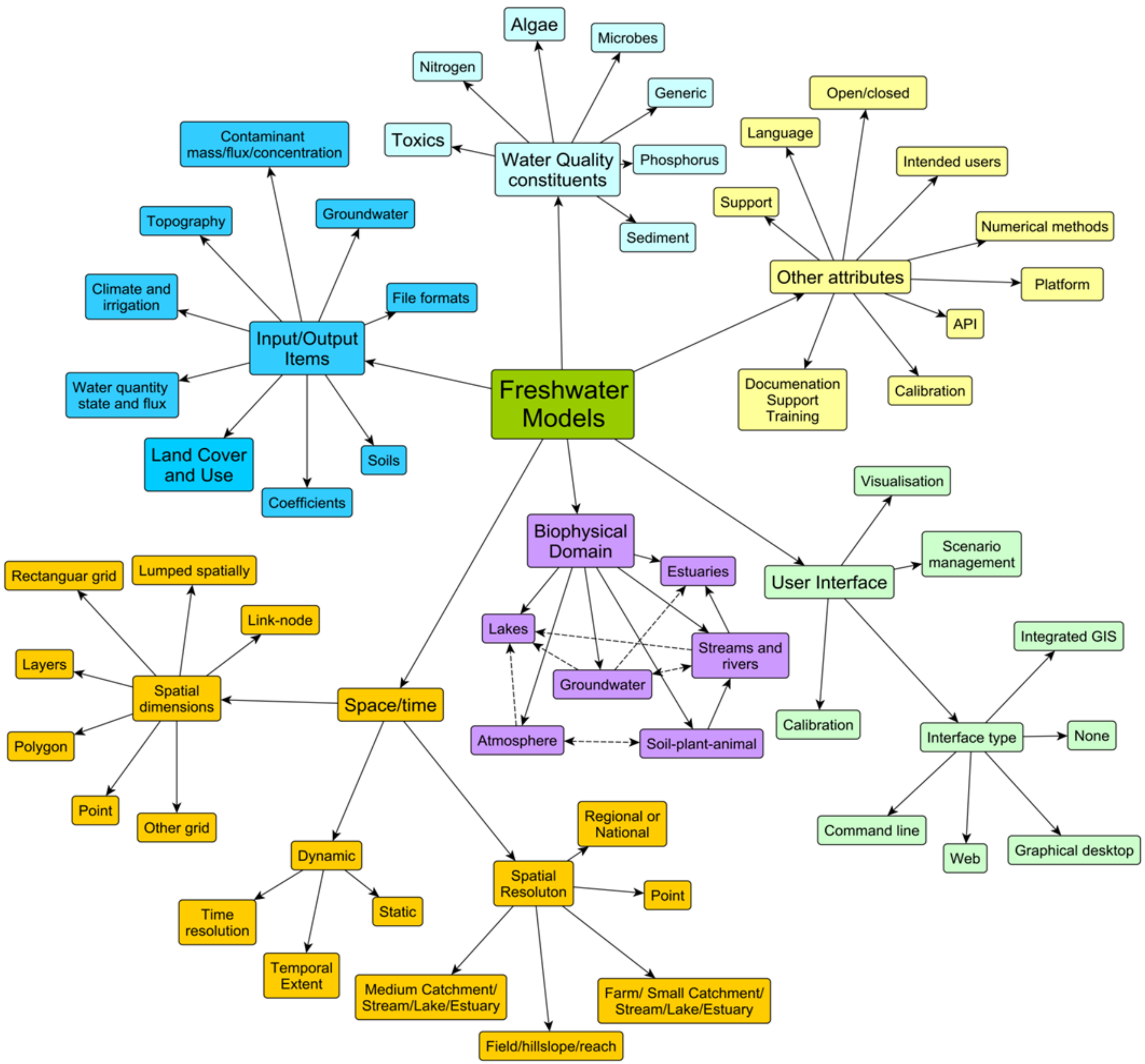
Compilation of models and their attributes

Model Summary

Click here to create a new Model Description Page (if you have editing permissions)

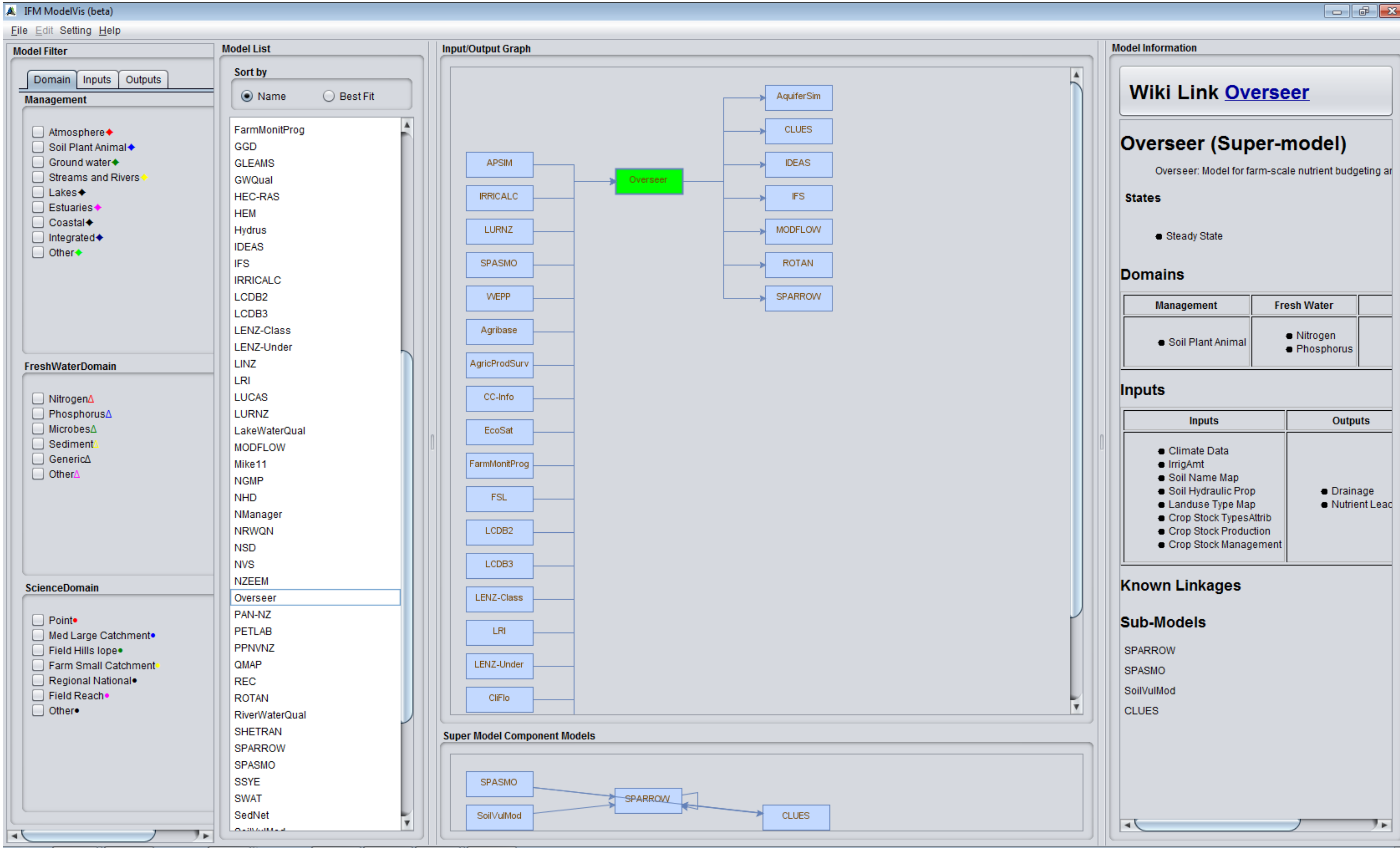
Title	Description	Biophysic Domain
APSIM	APSIM is internationally recognised as a highly advanced simulator of agricultural systems. It contains a suite of modules, or components, which enable the simulation of systems that cover a range of plant, animal, soil, climate and management interactions. It is undergoing continual development, with new capability added to regular releases of official versions over time. Its development and maintenance is underpinned by rigorous science and software engineering standards.	Soil-plant-
AquiferSim	AquiferSim is a GIS-based steady-state regional scale groundwater flow and contaminant transport model. It was developed as part of the multi-organisation IRAP (Integrated Research for Aquifer Protection) Project.	Groundwa Other
BNZ	Catchment-scale water quality model for sediment and nutrients. The daily USDA GLEAMS model is run for each unique grid cell and contaminant are then routed to the stream and down the stream network with attenuation.	Soil-plant- Streams a rivers
C-CALM	Catchment Contaminant Annual Loads Model Urban water quality model with a GIS platform (ArcMap - versions available for 9.3 and 10) which estimates the annual loads of TSS, zinc and copper (total, dissolved and particulate) generated by different land covers at the stormwater catchment scale. Based on the Auckland Council spreadsheet CLM model and has the same choice of land covers which represent different landuses and yields for those covers. Allows users to choose between a range of stormwater treatment options and the proportion of each land cover treated to reduce annual loads. Available on request from NIWA.	Streams a rivers, Est
CESIT	Linked catchment and estuary sediment deposition model. Includes a user interface. Mean annual sediment yields are predicted as a function of land use, soils, rainfall, and mitigation measures. Resulting loads decomposed into a time series which is fed to an event-based estuary dispersal model.	Soil-plant- Streams a rivers, Coa
CLUES (Catchment Land Use for Environmental Sustainability)	CLUES is a catchment model developed to address implications of land use scenarios on stream water quality and some socio-economic indicators.	Soil-plant- Streams a rivers, Lak Integrated
Delft3D	3D hydrodynamic model for rivers, estuaries and coastal seas. Includes sediment transport, and optional water quality components. Incorporates SWAN wave model. Includes morphological change in response to sedimentation.	Other
DHSVM	DHSVM is a distributed hydrological model that explicitly represents the effects of topography and vegetation on water fluxes through the landscape.	Soil-plant-

Organise models according to attributes

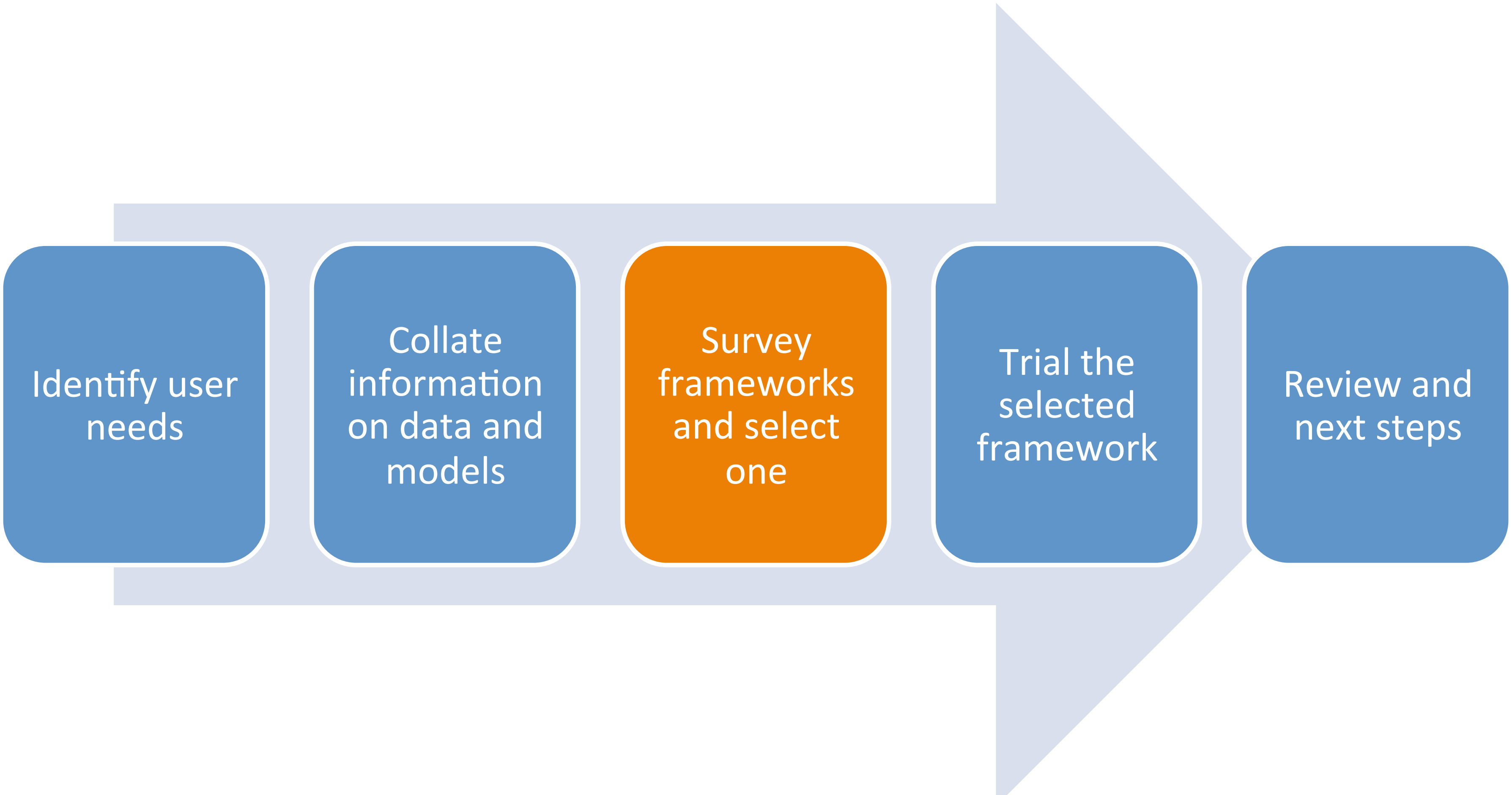


I/O items used to identify potential linkages

Potential linkages: ModelVis



Stages of our investigations



Inventory and Screening of Frameworks

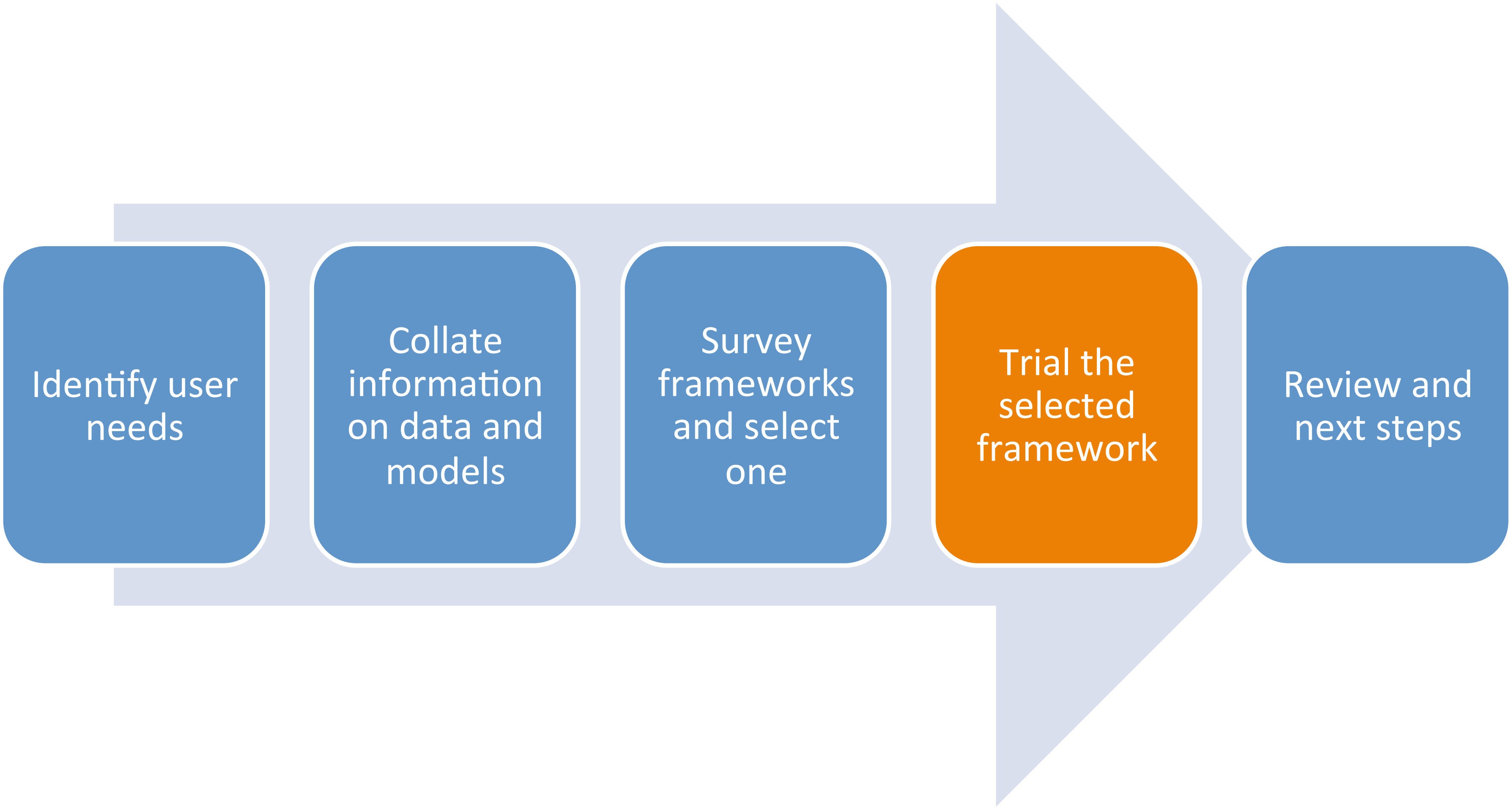
- APSIM
- Delft-FEWS
- Seamless
- OASIS
- ICMS
- EnSym
- Bespoke Framework Generator (BFG)
- Hydromodeler
- ESMF
- Hydrologists workbench
- GME
- CSDMS
- OMS3
- OpenMI
- OpenPalm
- TIME
- Pegasus

Screening of existing frameworks

● Criterion Met ● Criterion Partly Met ● Criterion Not Met ● Need More Info

Criteria	CSDMS	OMS3	OpenMI	OpenPalm	TIME	Pegasus
Can store model setup and data	Met	Met	Met	Met	Met	Met
Dynamic Models	Met	Met	Met	Met	Met	Met
Static Models	Met	Met	Met	Met	Met	Met
Can reconfigure components	Met	Met	Met	Met	Met	Met
Open source framework	Met	Met	Met	Met	Partly Met	Met
Freely available	Met	Met	Met	Met	Need More Info	Met
Open model interface standards	Met	Met	Met	Partly Met	Partly Met	Partly Met
Open data standards	Not Met	Partly Met	Partly Met	Not Met	Not Met	Not Met
Can work at range of scales	Met	Met	Met	Met	Met	Met
Spatial Models	Met	Met	Met	Met	Met	Met
Geospatial Data	Need More Info	Partly Met	Partly Met	Partly Met	Met	Not Met
Likely longevity	Met	Met	Met	Met	Need More Info	Met
GUI for set-up	Met	Met	Met	Met	Met	Met

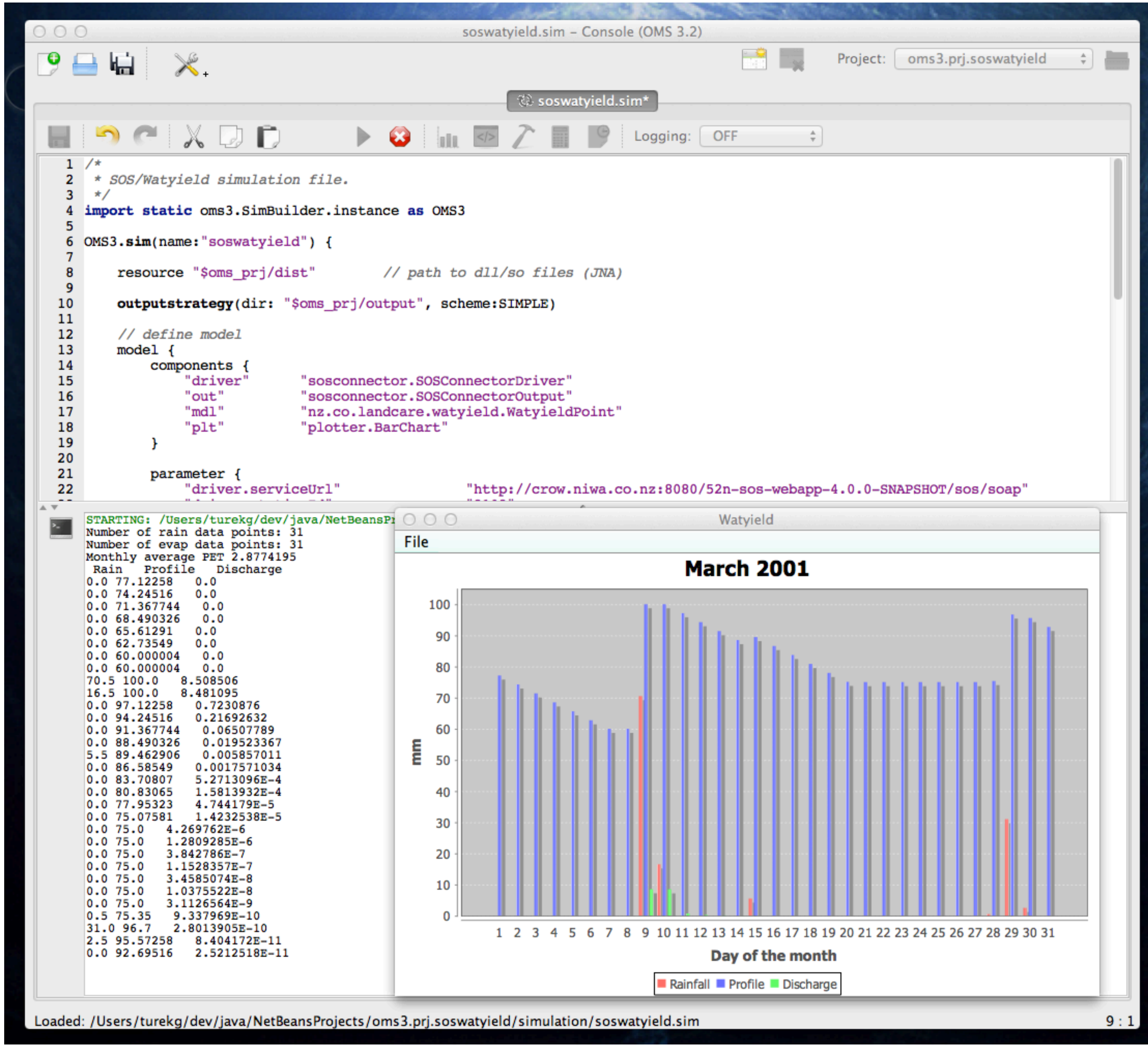
Stages of our investigations

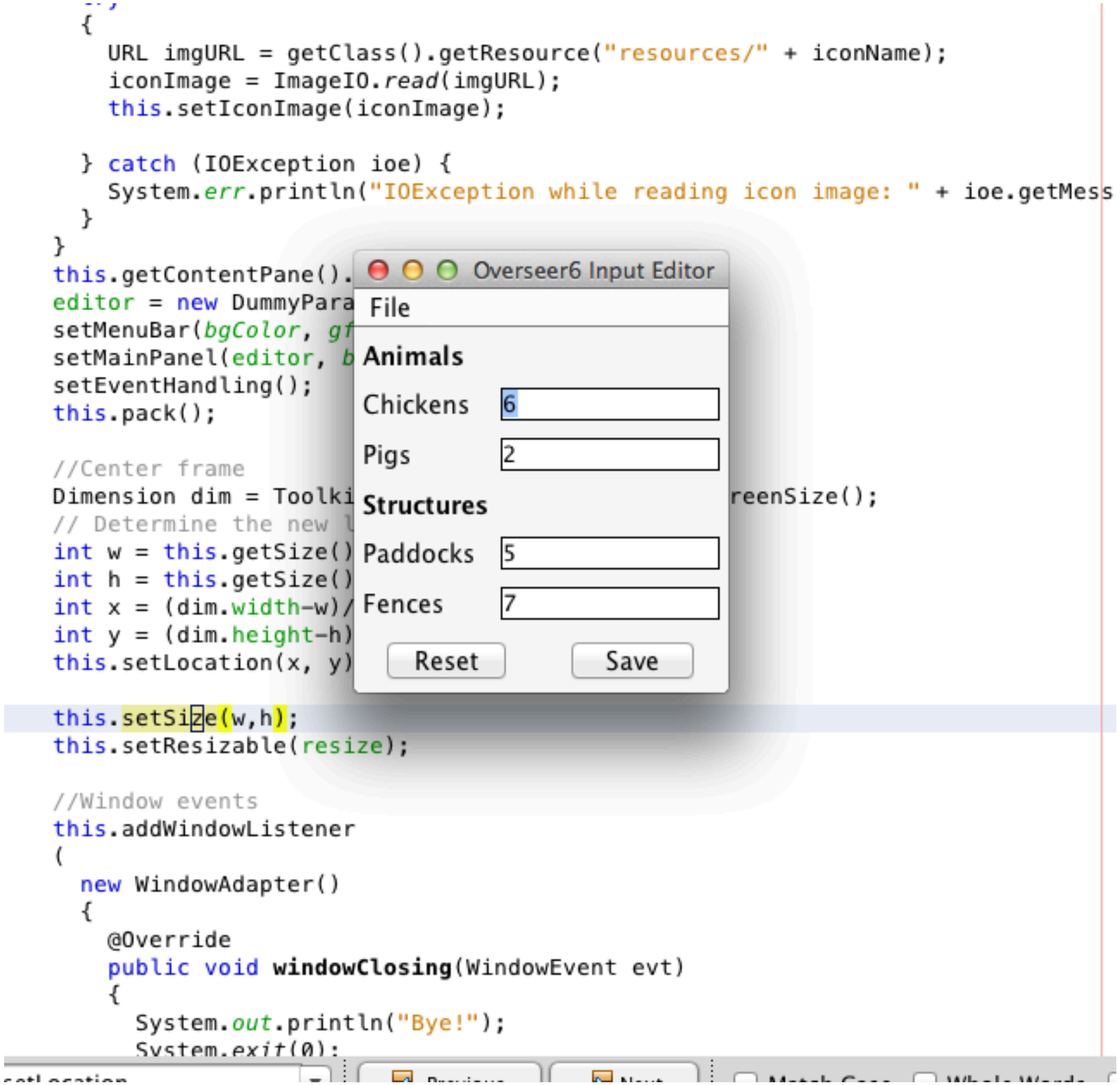


Targeted Tests

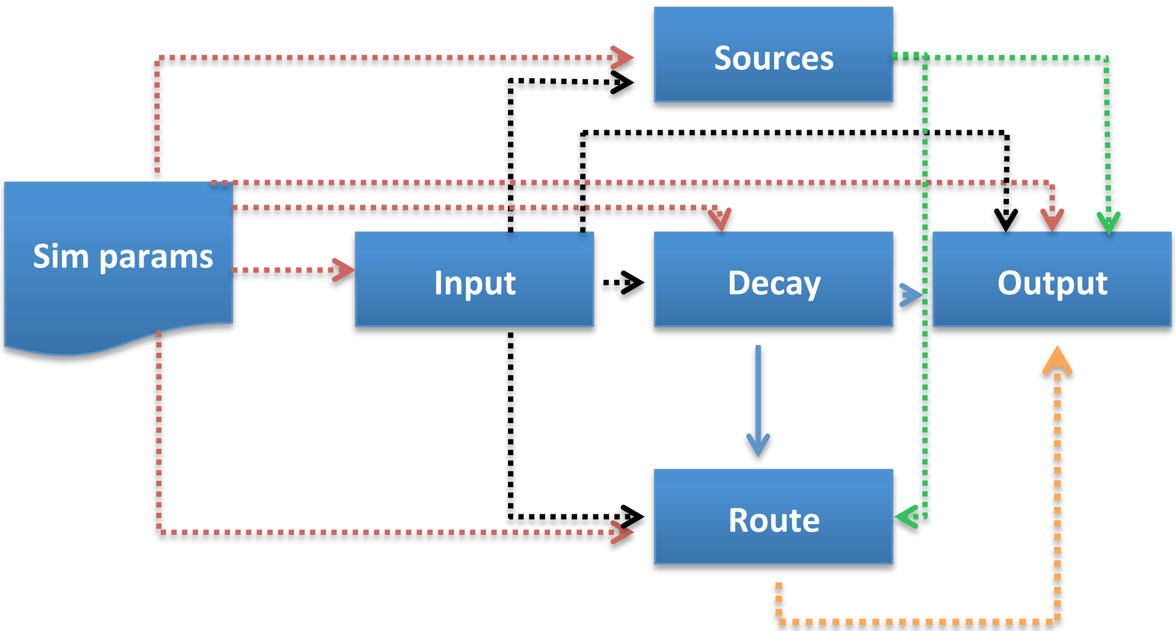
Feature being tested	Specific Test
Set up point-scale dynamic model	Set up Watyield hydrology model
Get temporal input data from a web service and link to a model	SOS web service for climate data into WatYield
View model results	Watyield time series using using JFreeChart
Link to spatial data provided as web service	Get land cover and climate input from an OGC-compliant web service using wget requests
Manipulate spatial data	Use GDAL processing libraries to manipulate spatial input to Watyield
Set up and run a spatial model	Run Watyield point model over a grid
Set up legacy models from various formats	Overseer leaching model as dll's and web service. Fortran Sparrow model. Watyield from VB6
Develop simple user interface	Editor to manipulate fields in Overseer XML files and run modified model
Link models	Overseer -> Catchment model
Use components from other frameworks	Use APSIM components

WATYIELD OMS3 Screenshot




{
URL imgURL = getClass().getResource("resources/" + iconName);
iconImage = ImageIO.read(imgURL);
this.setIconImage(iconImage);
} catch (IOException ioe) {
System.err.println("IOException while reading icon image: " + ioe.getMess
}
}
this.getContentPane().
editor = new DummyPara
setMenuBar(bgColor, gf
setMainPanel(editor, b
setEventHandling();
this.pack();
//Center frame
Dimension dim = Toolki
reenSize();
// Determine the new l
int w = this.getSize()
int h = this.getSize()
int x = (dim.width-w)/
int y = (dim.height-h)
this.setLocation(x, y)
this.setSize(w,h);
this.setResizable(resize);
//Window events
this.addWindowListener
(
new WindowAdapter()
{
@Override
public void windowClosing(WindowEvent evt)
{
System.out.println("Bye!");
System.exit(0);
Overseer6 Input Editor
File
Animals
Chickens
6
Pigs
2
Structures
Paddocks
5
Fences
7
Reset
Save

Linking data and models



Positive results from OMS3 trialling

- Fairly easy to set up and link models
  - Fortran, porting code to Java, simple .NET dll's
- Can set up components for:
  - visualisation
  - access to data sources
  - simple user interface
  - geospatial data manipulation
  - access to models as a web service

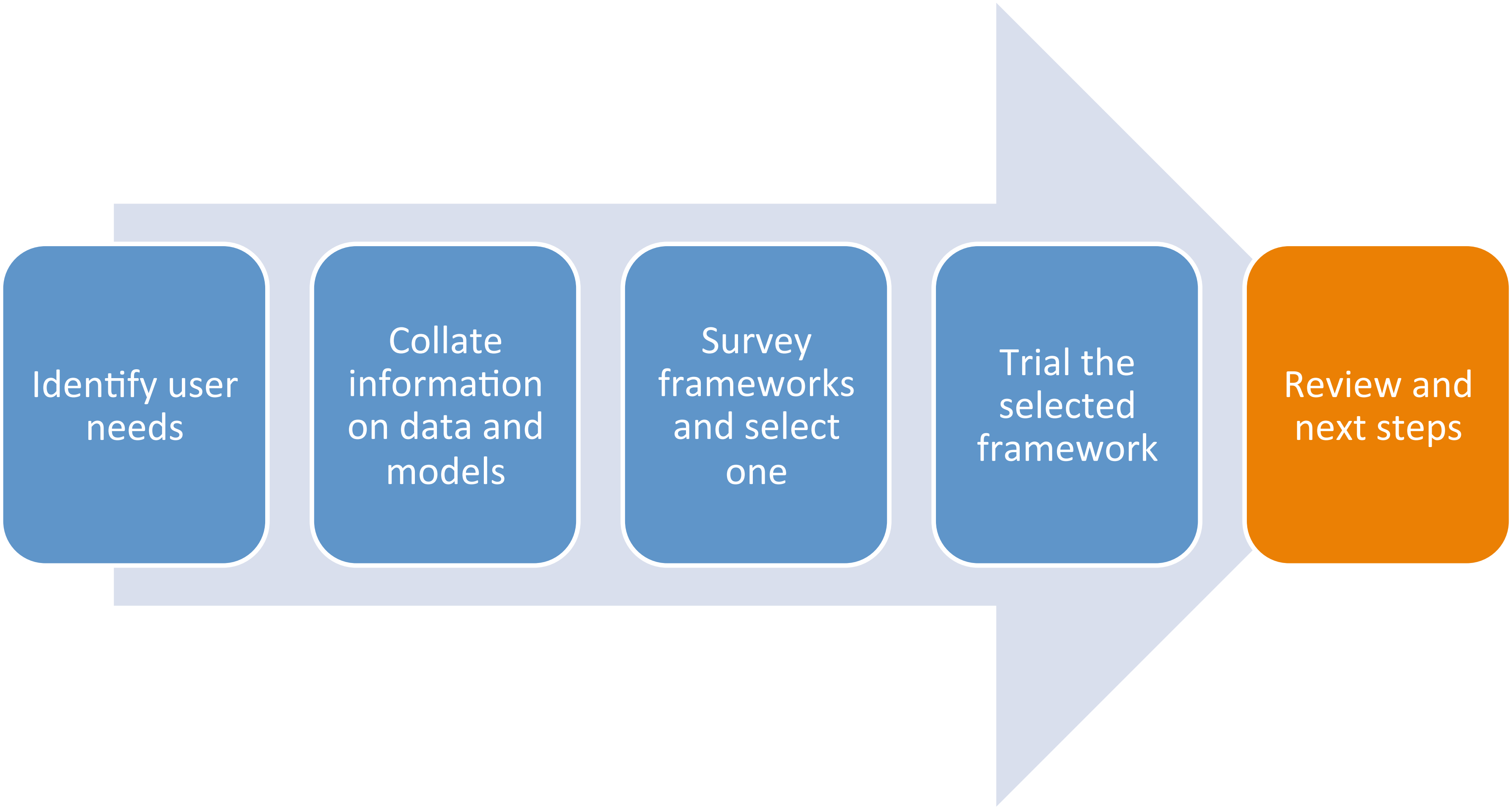
But…

- Requires moderate-high Java programming skills
- Difficult to link to complex .NET-based dll's
- User interfaces need to be built from scratch
- Limited geospatial and visualisation support
- No model repository

Unfinished business

- High-level users want to see a complex, polished, computationally-intensive application

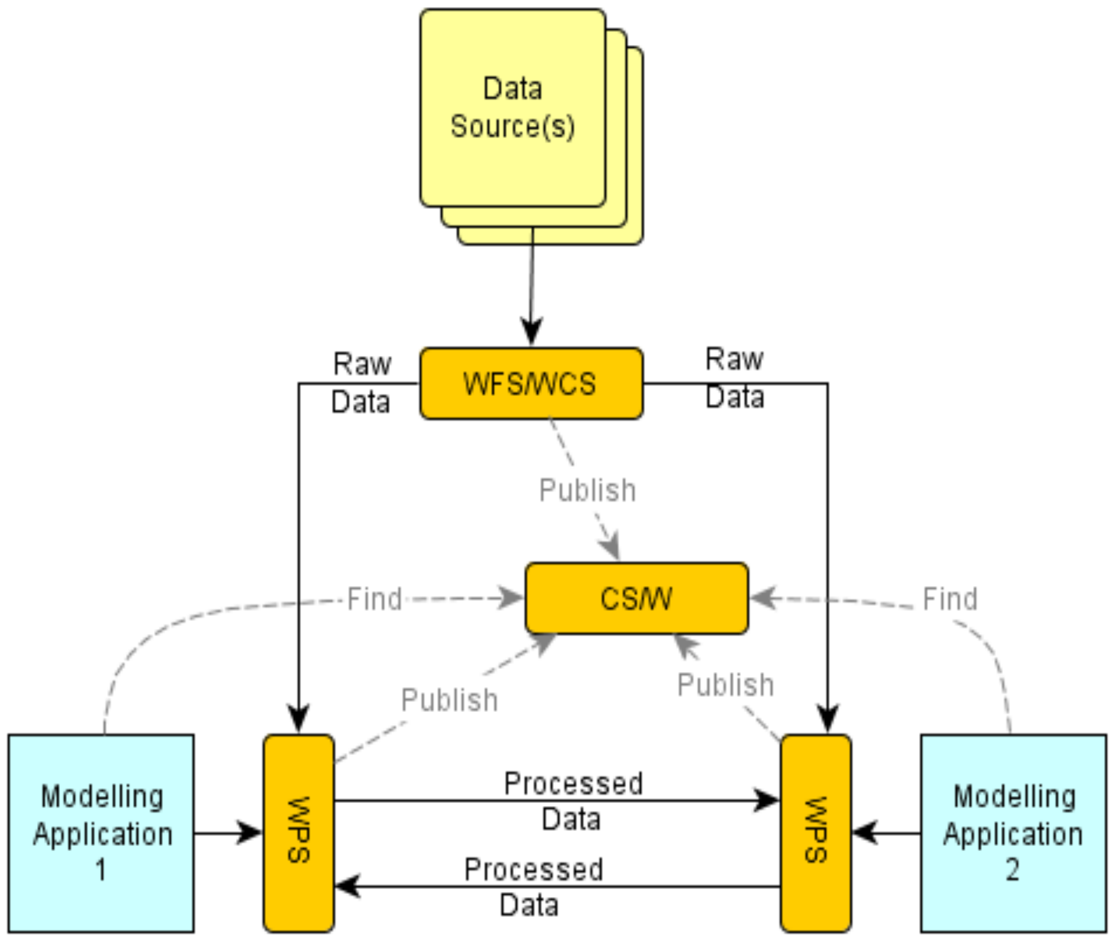
Stages of our investigations



Revisiting of alternatives

- OpenMI
  - Few OpenMI 2.0 –compliant models
  - Implementations of the standards are slow to appear
  - Frameworks such as OMS3 may adopt the standard
- Models as a service
  - Attractive for overcoming platform/language dependencies and IP barriers
  - Technologies immature (but developing quickly)

OGC SOS and WPS approaches



Next steps

- Build a full polished demonstration application of OMS3
- Continue on a staged path for web services
  - OGC data as OMS3 components
  - Web services as OMS3 components using WPS
  - Future web-centric framework?

Conclusions

- Initial trialling of OMS3 was promising, but more needed on user interfaces and domain-specific data structures
- Users need to see a polished local example before they will commit fully
- Expect to transition gradually to models-as-a-service, building on data interoperability

Acknowledgment

- David Olaf (CSU)
- Joel Rahman, Peter Fitch, David Lemon (CSIRO etc.)
- All attendees of workshops and contributors to the wiki

END