# **Open science for collaborative exploration of fluvial futures**

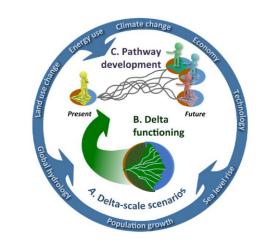
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## Motivation

Managing densely populated fluvial areas and adapting to climate-change present major challenges for sustainable development. To democratise the decision-making process it is desired that stakeholders and planning professionals can evaluate common interventions by straightforward access to intervention plans, source data, and model code. **We aimed at the creation of an interactive environment based on free and open-source software for intervention planning and evaluation.** We used RiverScape (Straatsma et al., 2017, 2018, 2019), which is based on the spatio-temporal modelling environment PCRaster (Karssenberg et al., 2010). We developed Jupyter notebooks to integrate explanatory text, user-defined parameterisation of measures, execution of RiverScape (Fig. 1) code, and

### - Feedback -

Download the repository to plan and evaluate your own measures!



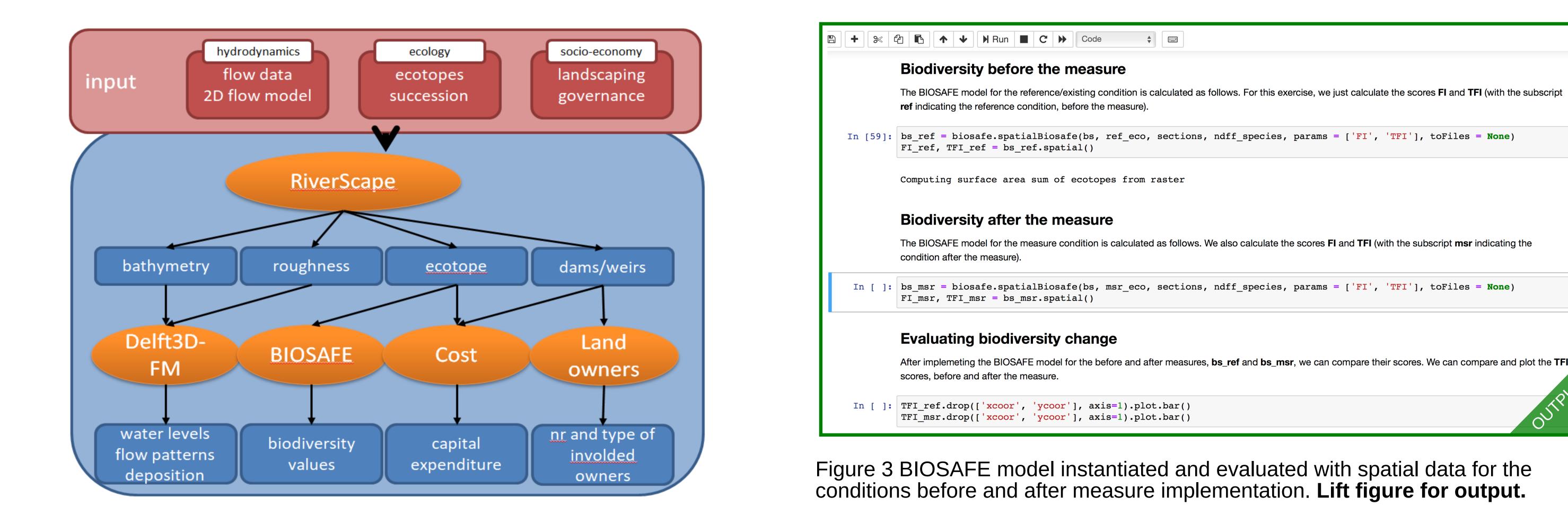
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#### interactive visualisation. All within your browser.





### Figure 1. Typical workflow to generate and evaluate interventions. Interactive Jupyter notebooks

#### Exploring a set of existing measures

To provide insight into the trade-offs of measures between water level

#### The intervention plannning notebook

In the intervention planning notebook you can position and parameterize typical river interventions. Spatial input data such as terrain, ecotopes and trachytopes can be visualised and inspected interactively. The areas of measures can be specified arbitrarily, e.g. everywhere, per floodplain section or per owner. The following measures can be parameterised: side channel creation (Fig. 2), floodplain lowering, groyne lowering, minor embankment lowering, main dike raising and roughness smoothing

	Side channel measure: Specify your own side channel properties: 1 The measures are configured with certain properties. You can inspect and change a few of them: settings = riverscape.measures_settings()				
In [22]:					
	smoothing_percentage	e 100	¢	This user-specified percentage is required for vegetation roughness measure. The score at a specific	
				percentile of the distribution is used as a threshold for positioning the roughness smoothing. Areas	
				where alpha, the product of specific discharge and Nikuradse equivalent roughness length, exceeded	
				the percentile score are selected for roughness smoothing. The percentile is calculated as 100 minus	
				the user-specified percentage smoothing_percentage of the terrestrial floodplain area.	
	smoothing_ecotope	UG-2	~	The (new) ecotope unit that is applied for the smoothing measure	
	smoothing_trachytope	1201	~	The (new) trachytope unit that is applied for the smoothing measure	
	lowering_percentage	100		This user-specified percentage is required for floodplain lowering measure. Floodplain lowering is	
	-			positioned where water depth exceeded the score at a certain percentile that equals 100 minus the	
				user-specified lowering_percentage.	
	relocation_ecotope	HG-2	~	The (new) ecotope unit that is applied for the relocation measure	
	relocation_trachytope	1201	~	The (new) trachytope unit that is applied for the relocation measure	
	You may want to moc	lify the side ch	annel prope	ties using the following interactive cell. Note that height and width are not true to scale.	
In [23]:	<pre>channel_values = riverscape.channel_properties()</pre>				
	Width [m]	•	85		
	Depth [m]		3.25		

lowering, biodiversity, implementation costs and number of land owners show all interventions in a scatterplot matrix (Fig. 4). The lower left corners of each panel indicates the utopian situation; the upper right the situation gets dystopian. Pareto fronts indicate the measures with optimal combinations of the evaluated parameters.

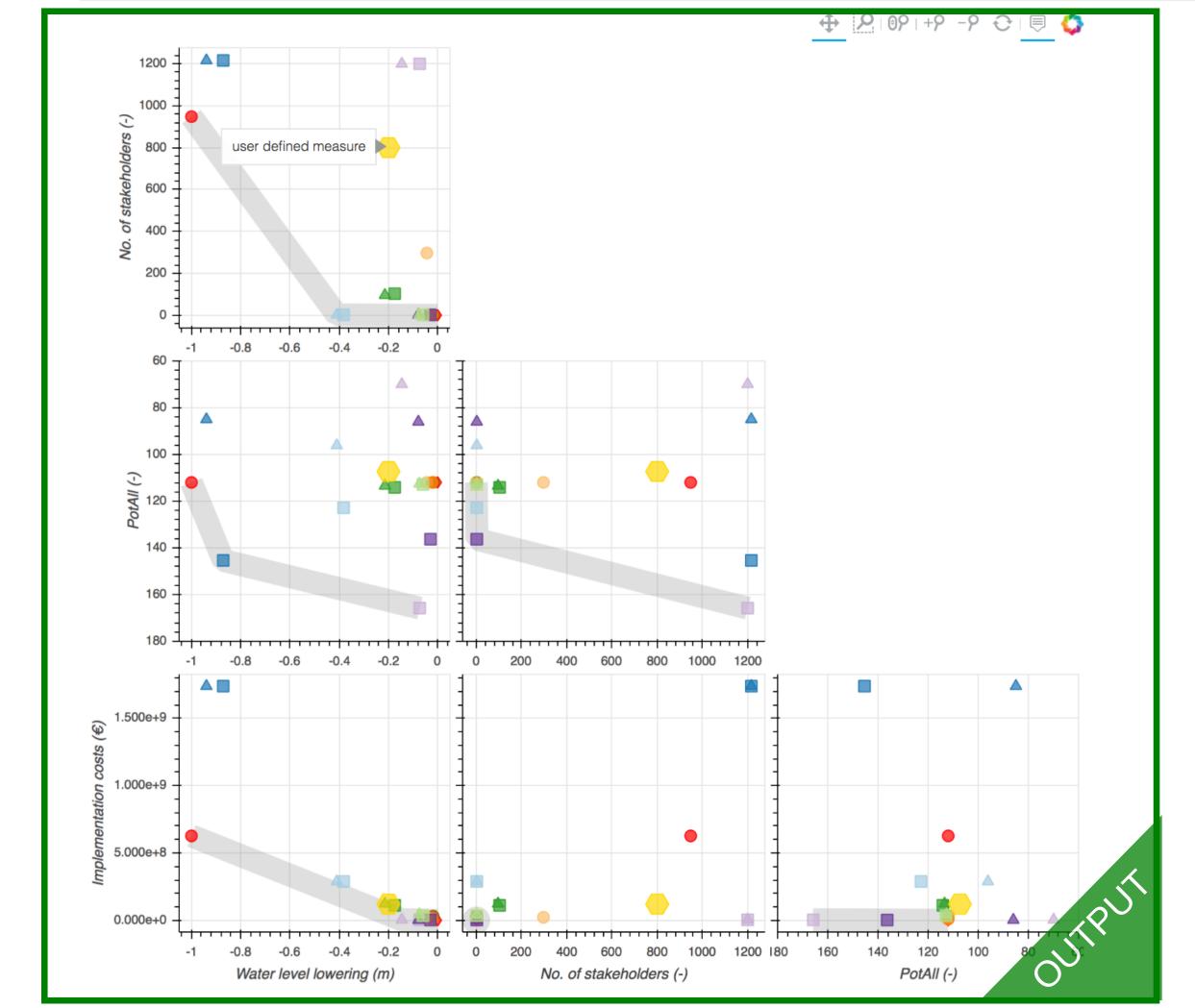
#### 

You can also compare effects of your measures with other measures by adding your measure (i.e. position in the state space) to the scatterplot matrix. Specify your inputs by using values from the previous notebooks or use default values.

In [12]:	<pre># Measure label label = 'user defined measure'</pre>
	<pre># Water level lowering delta_water = -0.20</pre>
	<pre># Involved stakeholders nr_stakeholders = 800</pre>
	<pre># Estimated costs implementation_costs = 120000000</pre>
	<pre># Biodiversity score potAll = 107.3</pre>

and plot the scatterplot matrix again with your data added. Your measure will show up as golden hexagonal marker.

In [13]: riverscape.plot\_scatter(label, delta\_water, nr\_stakeholders, implementation\_costs, potAll)



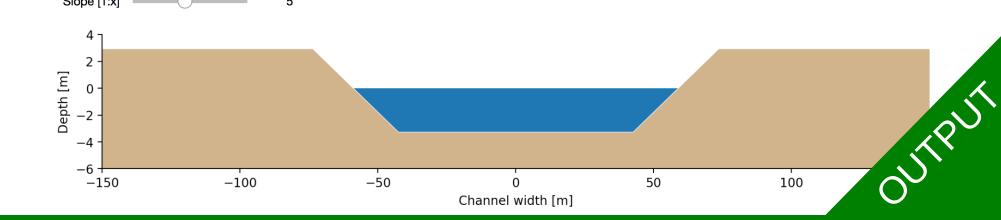


Figure 2. GUI input for side channel parameterization. Direct feedback is provided by interactive graphs such as the changing channel transect. Lift figure for output.

### The biodiversity evaluation notebook

Evaluating the effects of the measure on biodiversity is crucial to comply with the national and international regulations. The notebook the BIOSAFE model (de Nooij et al., 2003), where various biodiversity scores can be evaluated for seven taxonomic groups. BIOSAFE can be executed as a non spatial model, or fed with ecotope maps and spatial observations of species monitoring data (Fig. 3).

Figure 4 Multiparameter evaluation of existing measures compared with user-defined measure.

#### References

Karssenberg et al (2010) https://doi.org/10.1016/j.envsoft.2009.10.004 de Nooij et al. (2003) https://doi.org/10.1002/rra.779 Straatsma et al (2017) https://advances.sciencemag.org/content/3/11/e1602762 Straatsma et al (2018) https://doi.org/10.1016/j.envsoft.2017.12.010 Straatsma et al (2019) https://doi.org/10.5194/nhess-19-1167-2019