

Making a spatial opportunity costs layer

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Phnom Penh, June 2015

Spatial layers for costs & benefits in the GIS tool – Opportunity costs

- **Opportunity costs** –i.e. the foregone potential income from alternative land uses when one land use is chosen
 - what are the opportunity costs associated with different drivers?
 - what is the likely spatial distribution of a driver in the future under BAU?
 - what would be the foregone potential income under REDD+ over a given time period? (minus any input costs incurred to carry out the BAU activity)

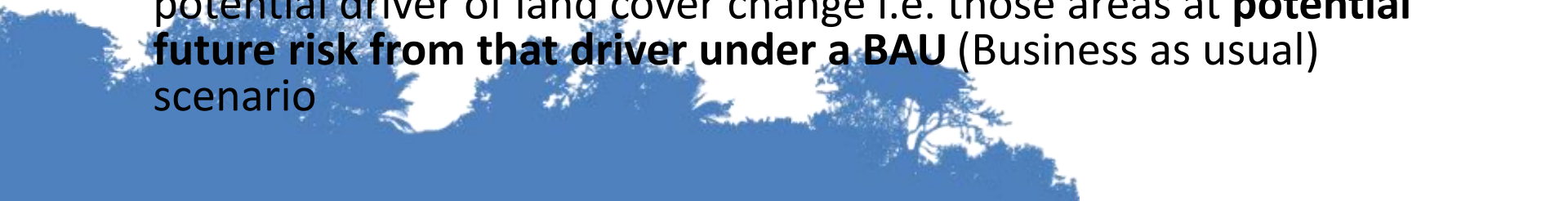
Generating a spatial opportunity costs layer

- ❑ The **opportunity costs** should be associated only with those **areas at risk from the chosen driver**
- ❑ **Many opportunity costs layers – one for each driver**

e.g. If the driver is Small-scale use: Cassava

Where is there potential for small-scale cassava production?
and what profits does this activity generate?

your opportunity cost is the profits from cassava that will be lost when you choose another land-use (for example, implementing a REDD+ action)

- ❑ **include only** areas where the **chosen driver** has been identified as a potential driver of land cover change i.e. those areas at **potential future risk from that driver under a BAU** (Business as usual) scenario
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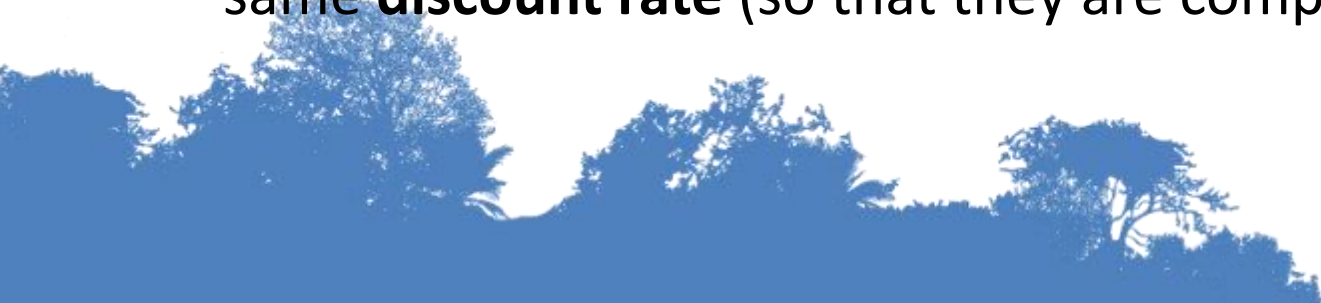
Generating a spatial opportunity costs layer

- ❑ Each alternative land-use is a separate layer:
 - **1 layer per driver** (e.g. rubber, cashew, large-scale & small scale rice, charcoal, pepper, luxury timber, clear felling) **indicating:**
 - the spatial distribution of the potential areas where this driver may occur
 - **profit** (revenues minus costs) on an **annual basis**, over a **25 year period**.

- ❑ Why?
 - because the spatial tool will assess the potential foregone profits from BAU (i.e. these land-uses/drivers) in areas where a REDD+ option is being implemented (i.e. the opportunity costs of implementing REDD+)

Accounting for the 25 year time period in the spatial opportunity costs layer

- ❑ To be able to compare values clearly a **Net Present Value (NPV) in US\$ per hectare** is calculated.
 - brings back the sum of future costs and benefits to a current value (using a **discount rate**, i.e. to reflect the **lower value that money has in the future compared with having it available now**).
- ❑ The **NPV is calculated separately for each driver** using the same **discount rate** (so that they are comparable).



How is Net Present-day Value calculated?

1)
$$\left[\begin{array}{c} \text{YIELD} \\ \text{(Y)} \end{array} \right] \times \begin{array}{c} \text{PRICE} \\ \text{(P)} \end{array} - \begin{array}{c} \text{COST} \\ \text{(C)} \end{array}$$
 SPATIAL INPUT LAYERS
(CALCULATING PROFITS)

2) NPV is calculated as:

$$\text{profits} / (1 + \text{discount rate})^{(\text{year}1)} + \text{profits} / (1 + \text{discount rate})^{(\text{year}2)} + \text{etc.}$$

Example Inputs

VARIABLE ASSUMPTIONS

Whilst all of the underlying values ca

Total area of Protected Forests

Economic values:

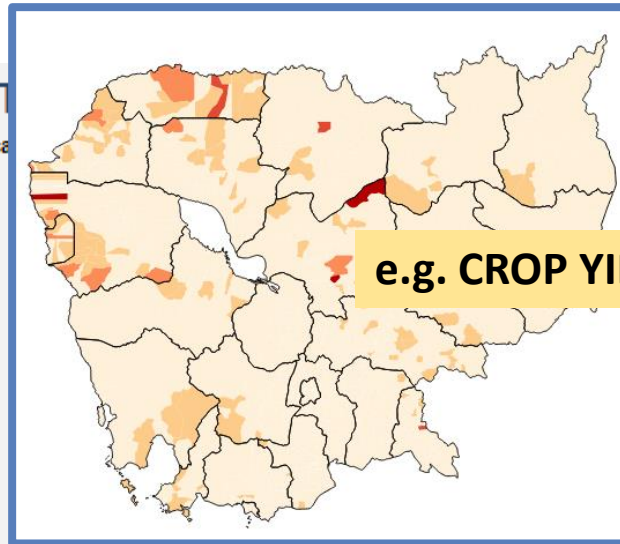
Discount rate
Carbon price

Alternative land uses:

Large-scale rice yield
Small-scale rice yield
Cassava yield
Rubber yield (max at maturity)
Oil Palm price
Cashew price

e.g. PRICE (FROM EXCEL SPREADSHEET TOOL)

Rubber price 140 US\$/tonne
Rice price (small scale) 360 US\$/tonne
Pepper price 350 US\$/tonne
Cassava price 30 US\$/tonne
Charcoal price 100 US\$/tonne
Standard timber price 500 US\$/m³
Luxury timber price 2,000 US\$/m³



e.g. CROP YIELD (YIELD/HA BY COMMUNE)

Graduated

Column: CassaYield

Symbol: [empty]

Color ramp: [source]

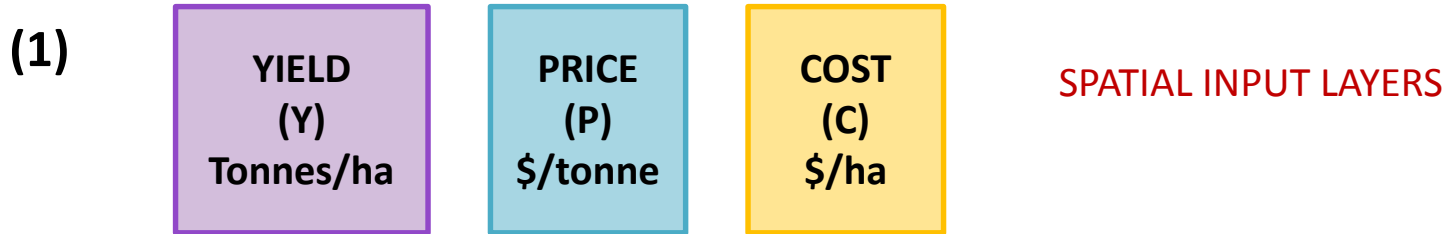
Legend Format: %1 - %2

Symbol	Values	Legend
X	0.00 - 19.60	0.0 - 19.6
X	19.60 - 39.20	19.6 - 39.2
X	39.20 - 58.80	39.2 - 58.8
X	58.80 - 78.40	58.8 - 78.4
X	78.40 - 98.00	78.4 - 98.0

Average size	Input costs (US\$ per hectare):	7	7	7	7	7	7	7	7
	Plant stems (for planting)								
	Fertilizer					32	33	34	34
	Chemicals					10	11	11	11
	Tractor for ploughing					57	57	57	57
	Other inputs					14	14	14	14
	Labour = own					0	0	0	0
	Total costs	118	119	119	120	121	122	122	123

e.g. INPUT COSTS (FROM EXCEL SPREADSHEET TOOL)

Creating a basic opportunity costs layer over a time period



(2) Apply NPV equation

$$(((Y \times P) - P) / (1 + 0.05)^1) + (((Y \times P) - P) / (1 + 0.05)^2) +$$

$(((Y \times P) - P) / (1 + 0.05)^3) \dots\dots\dots$ until the exponent reaches the number of years that you are using for the time period

Each of these is the NPV for a particular year (year determined by exponent)

(3) Your output raster should be the NPV over the number of years used

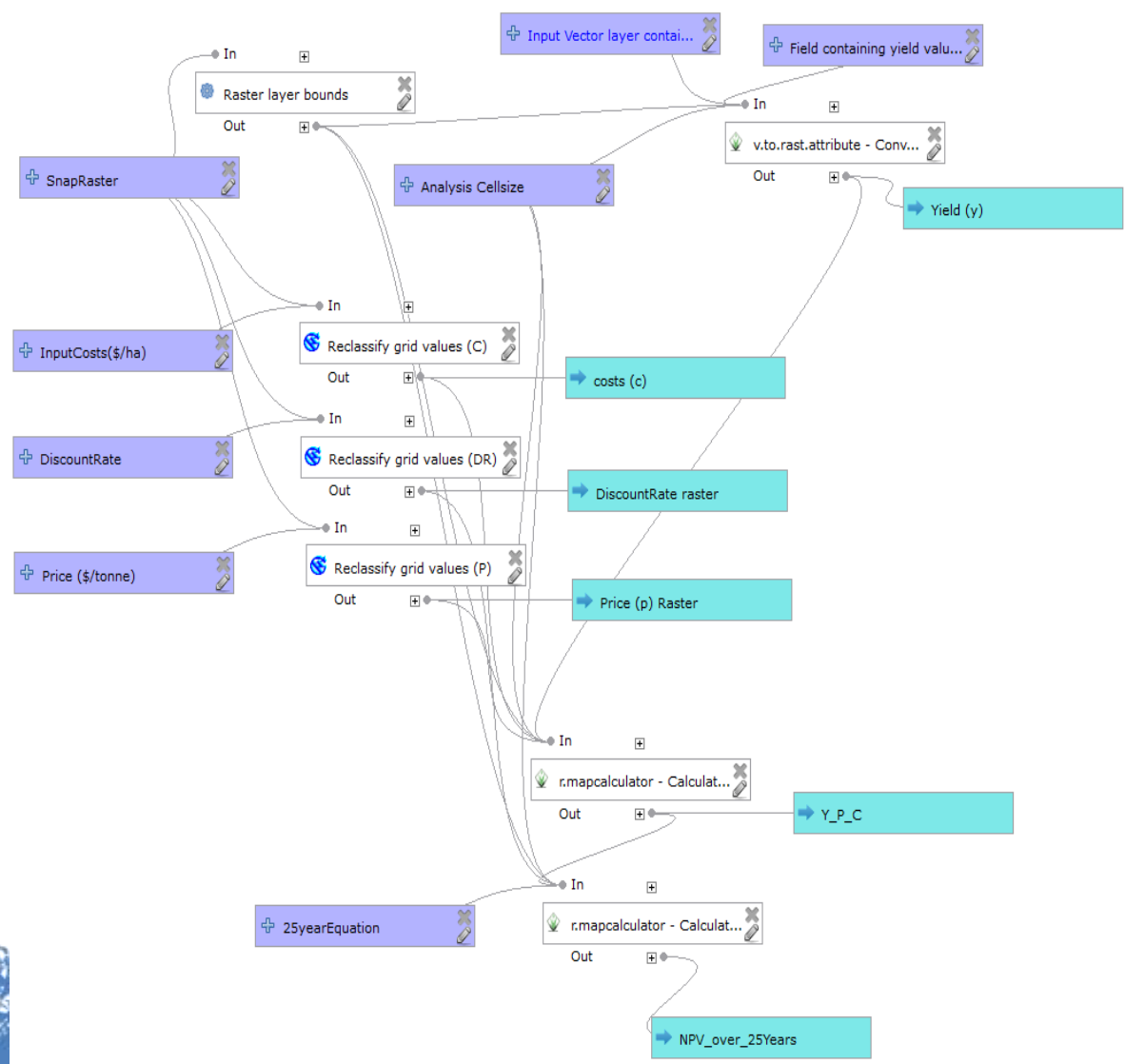
Assumption in this example: Yield , Price and Cost do not change i.e. the same spatial layers are used for Yield, Price and Cost in years 1,2,3 4 etc.

What does it look like if we generate a workflow in QGIS?

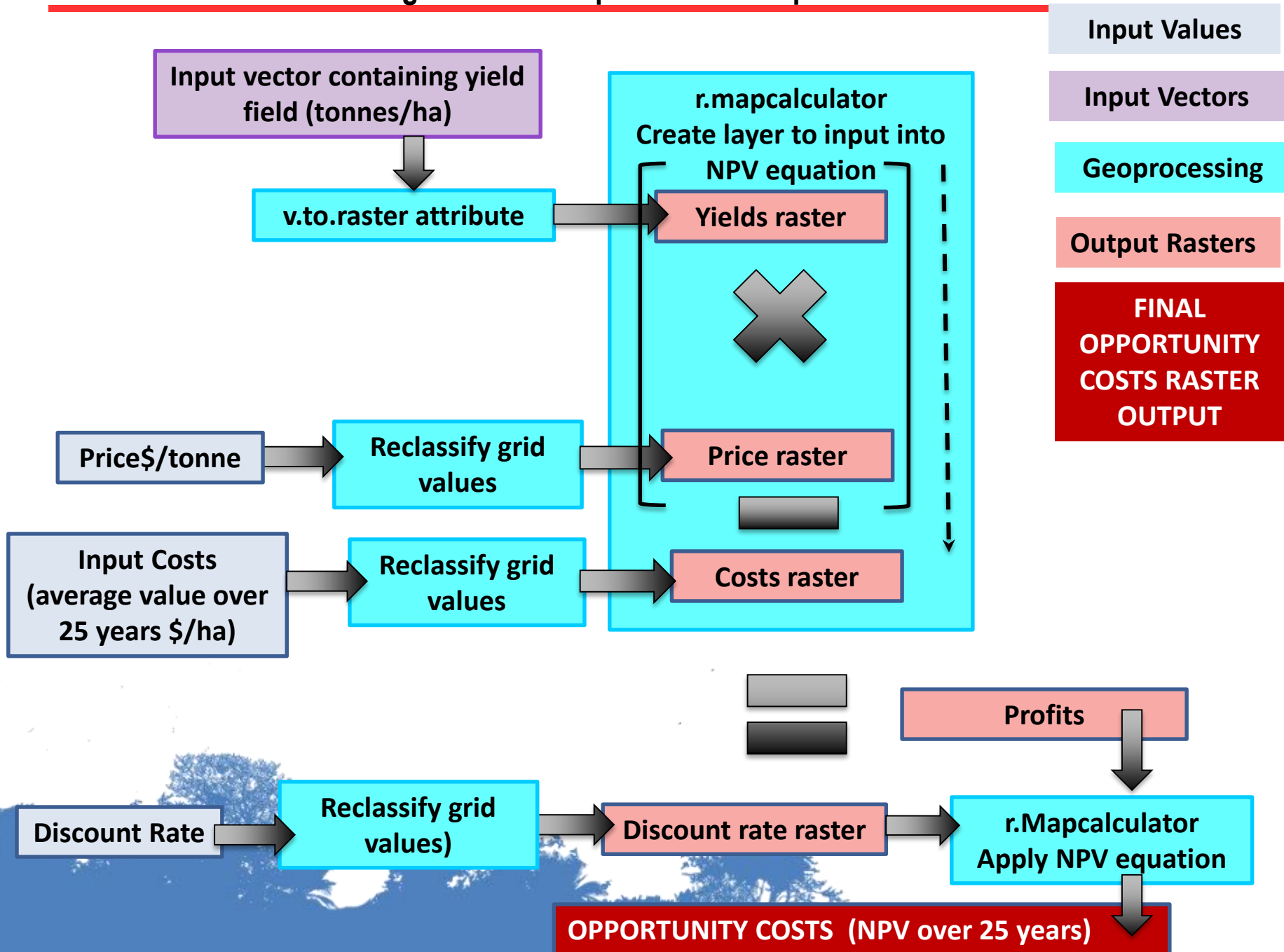
The dialog box shows the following parameters and options:

- Parameters: Log, Help
- SnapRaster [optional]: [Not selected]
- Input Vector layer containing yields [optional]: [Not selected]
- Field containing yield values in (tonnes/ha): [Empty]
- 25yearEquation: $(A/(1+B)^1) + (A/(1+B)^2) + (A/(1+B)^3) + (A/(1+B)^4) + (A/(1+B)^5)$
- InputCosts(\$/ha): 128
- DiscountRate: 0.050000
- Price (\$/tonne): 30
- Analysis Cellsize: 1000
- Y_P_C: [Save to temporary file]
- Open output file after running algorithm
- NPV_over_25Years: [Save to temporary file]
- Open output file after running algorithm
- Price (p) Raster: [Save to temporary file]
- Open output file after running algorithm
- costs (c): [Save to temporary file]
- Open output file after running algorithm
- DiscountRate raster: [Save to temporary file]
- Open output file after running algorithm
- Yield (y): [Save to temporary file]
- Open output file after running algorithm

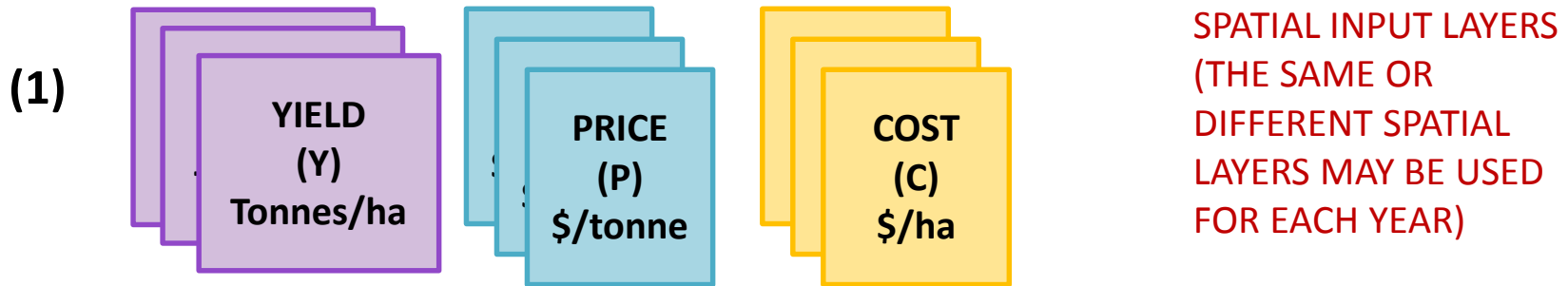
Progress bar: 0%
Buttons: Run, Close



Breaking down the steps: A more simple visualisation



Creating a more complex opportunity costs layer over a time period



YEAR	YIELD	PRICE	COST	EQUATION
1	Y	P	118	$((Y \times P) - 118) / 1 + 0.05)^1$
2	Y	P	119	$((Y \times P) - 119) / 1 + 0.05)^2$
3	Y	P	119	$((Y \times P) - 119) / 1 + 0.05)^3$
4	Y	P	120	$((Y \times P) - 120) / 1 + 0.05)^4$
5	Y	P	121	$((Y \times P) - 121) / 1 + 0.05)^5$
6	Y	P	122	$((Y \times P) - 122) / 1 + 0.05)^6$
etc.	etc.	etc.	etc.	etc.

e.g. costs may vary

Year

Discount rate

Assumption in this example: costs increase over time, because more fertilizer is needed due to nutrient depletion in the soil

Activity: Generating a spatial opportunity costs layer

- 1) Examine the steps in the example workflow
- 2) Create your own opportunity costs layer using the basic workflow

Choose a driver:-

- You will need to have data that will enable you to create a spatial layer to show the potential areas at risk from that driver?
- What additional workflows are required to generate the drivers dataset?

What opportunity costs data do you have for that driver?

- attach opportunity costs to the areas at risk from the driver
- What costs data is available?
 - Values from the spreadsheet tool
 - Spatial layer containing yield values
 - tabular data containing yield values that can be attached to administrative boundaries?

(What do you do if using costs based on current yields in areas where current yields are 0? apply minimum or average yield value?)

What input costs data do you have for that driver?

- Values from the spreadsheet tool
- 

Activity: Generating a spatial opportunity costs layer

3) Think about the more complex opportunity costs workflow

- Do we have data that will enable us to create the more complex layer?

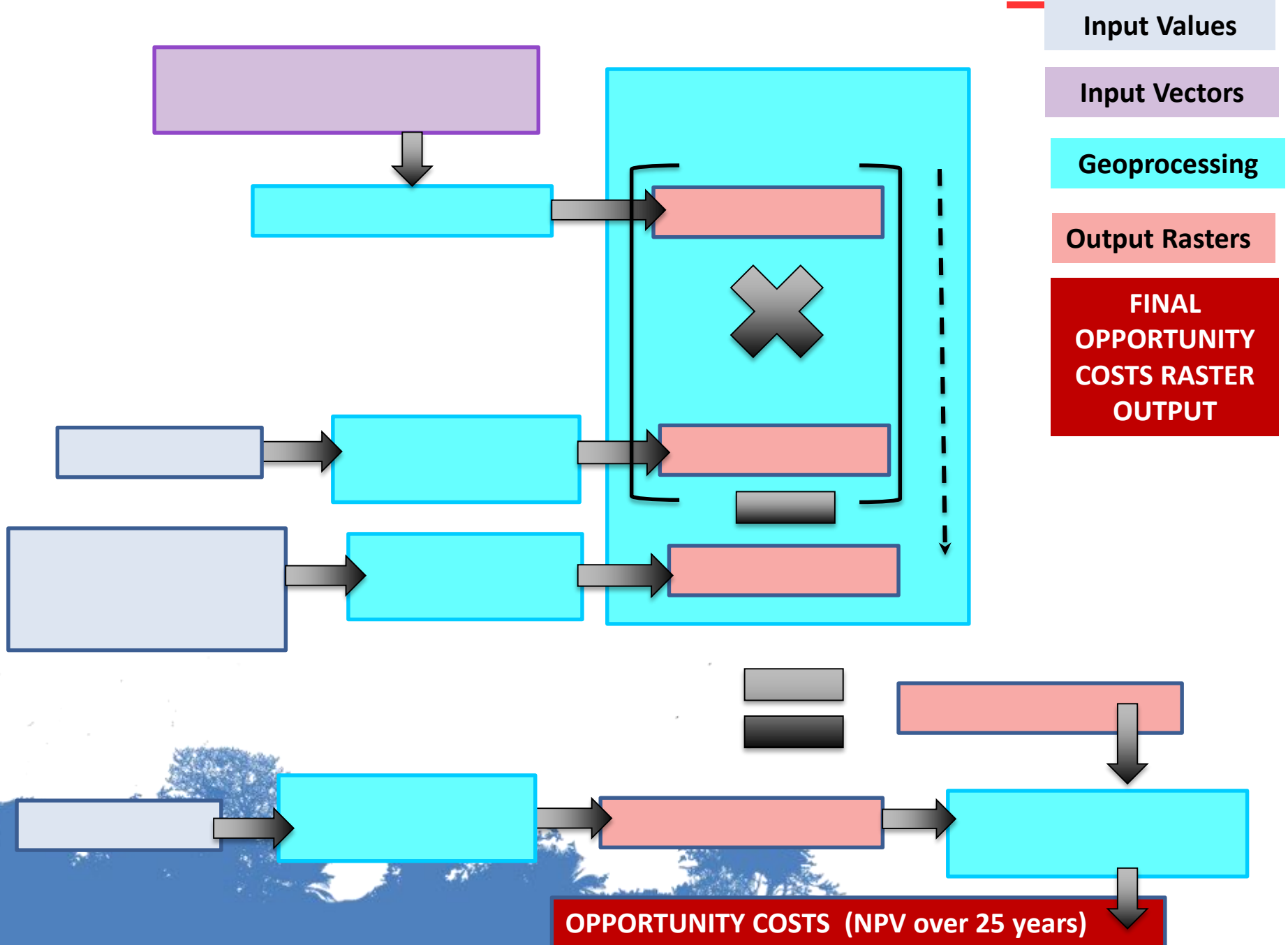
i.e. different input costs data for each year, different crop yields data for each year
(e.g. at high enough spatial resolution e.g. at commune level)

4) What other approaches could be taken to generate the opportunity costs layer?

- i.e. your own thoughts and ideas



Activity: Generating the opportunity costs layer: What data will we use for each step?



Thank you!

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