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AN INTRODUCTION TO WATERWORLD

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March 2016

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Hydrological services provided by forests

- Assumption of the past was that more forest = more water yield
- Highly contested topic in the scientific community: Question of scale
- Demand-side: Forests use a lot of water:
    - Intercept precipitation, evaporation and transpiration
    - Forest vegetation may remove water from the local water cycle, therefore decreasing downstream yields
- Supply-side: Forests may intensify water cycle at broader scales

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Hydrological services provided by forests

- Regulate seasonal discharge
- Reduce flooding at local scales
  - Large-scale flooding is influenced by basin-wide relationships between topography, runoff, regulation of water storage (e.g. lakes), discharge, groundwater tables tides etc.

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Hydrological services provided by forests

Maintain water quality

- Regulate soil erosion and reduce sediment loading
  - » Stabilization of slopes
  - » Roots trap sediments
  - » Lower canopy leaves and ground litter reduce splash force from precipitation
- Trap and filter water pollutants
  - » Generally no use of fertilisers or pesticides in natural forests
  - » Act as buffer zones between agricultural or industrial development and water bodies

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What is WaterWorld?

- Free web-based spatial modelling tool
- Models hydrology and soil erosion
- Complete set of data included, but possible to use own data to refine analysis
- Annual and monthly output maps downloadable in GIS formats
- Runs and compares scenarios of land use change and climate change fast (full analysis in 30 mins)
- Simple to use: Chrome or Firefox
- Includes free training programme

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What WaterWorld does?

Provides a spatially detailed and quantitative estimates of baseline hydrological values, as well as understanding of likely hydrological outcomes of scenarios (e.g. land use, climate change)

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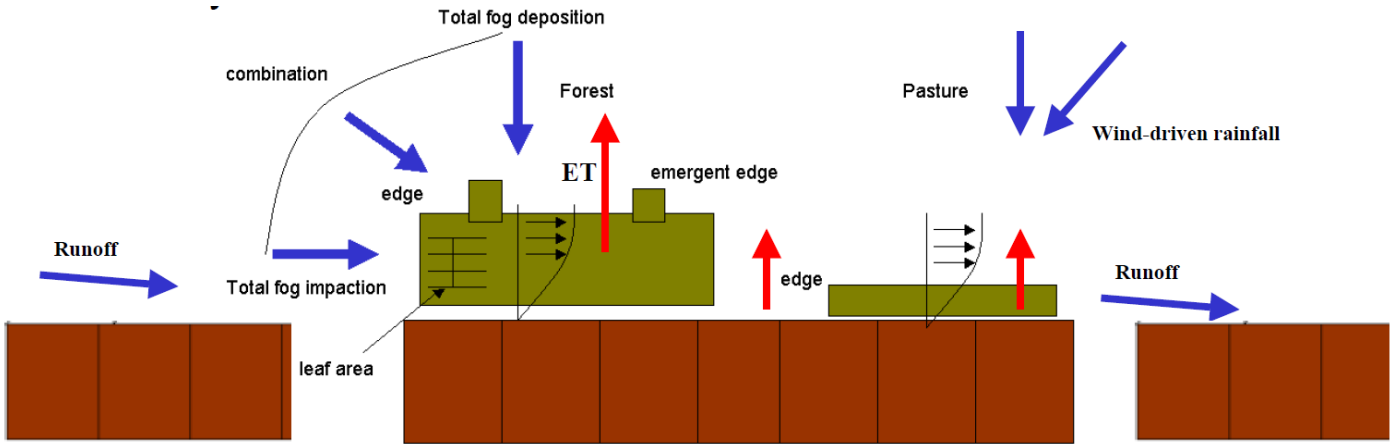
What WaterWorld does?

- For anywhere in the world, produces a **hydrological baseline** for a 1950-2000 baseline using more than 140 input maps.
- Does this at **1-hectare or 1-square-km** spatial resolution and monthly temporal resolution.
- Provides **scenario tools** for climate change and land use change
- Allows visualisation, analysis and GIS download of some **46 output variables**
- Allows summary of outputs according to watersheds, administrative areas, etc.

Scientific principles

- Based on FIESTA model (Mulligan and Burke, 2005; Bruijnzeel et al, 2011)
- Process-based (rather than empirical)
- Not calibrated (e.g. to observed measured flows)
- Gridded representation of water balance (wind-driven rainfall + fog minus evapotranspiration) (See Mulligan 2013).
- Changes in climate or land cover/use change water balances locally and downstream
- Erosion according to Thornes (1990).



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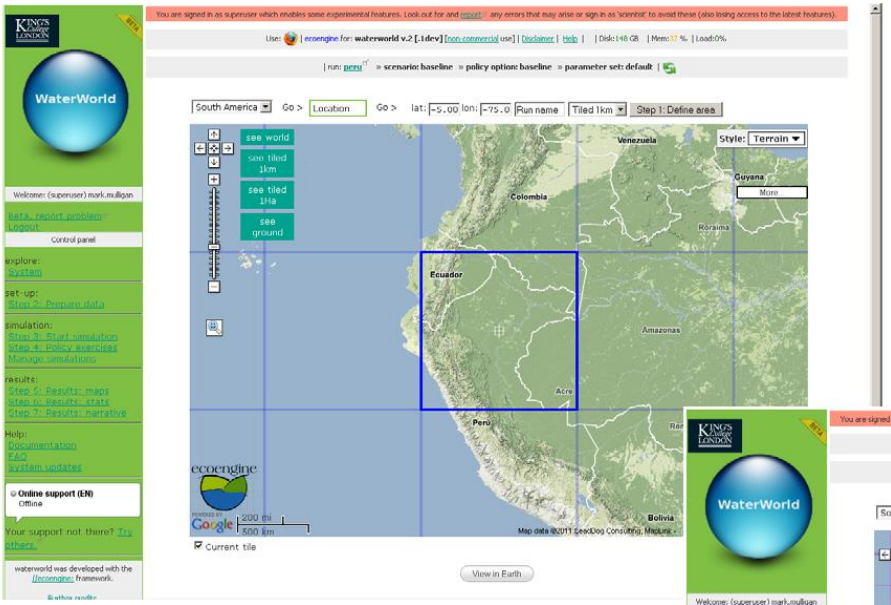
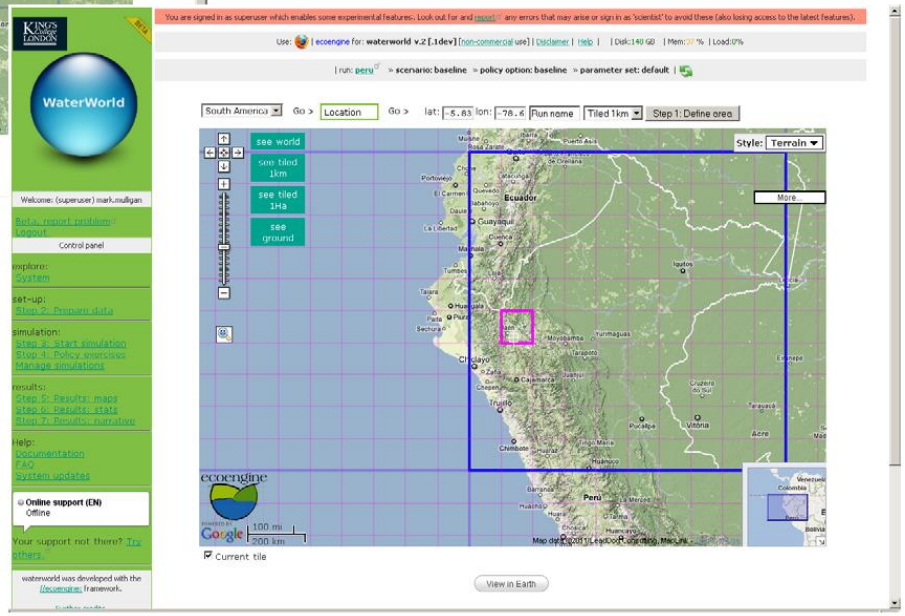
How to use WaterWorld



Step 1 Define area

Run anywhere globally for 1 degree (100km) tiles at 1-hectare grain,
OR 10 degree (1000km) tiles at 1-square-km grain.



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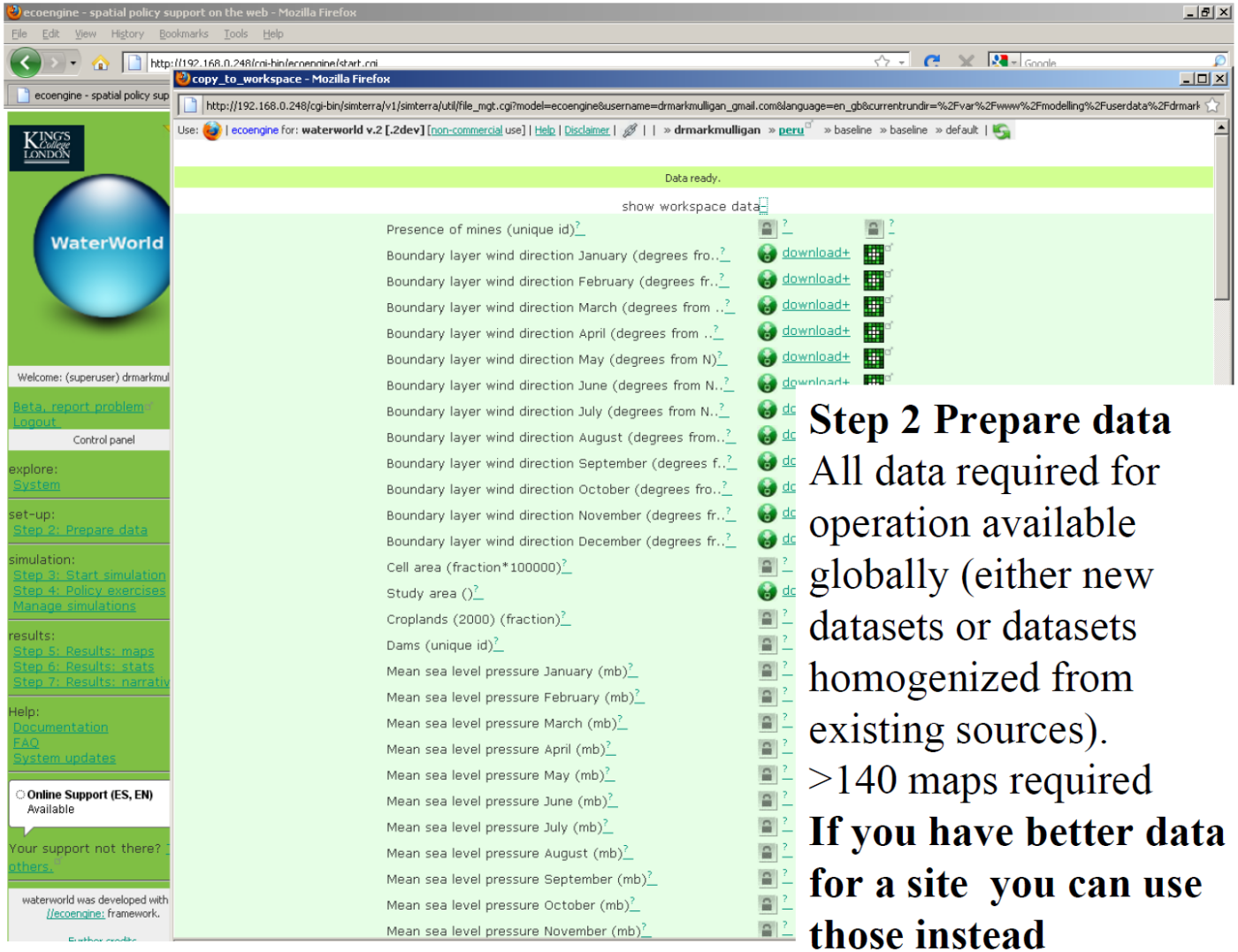

Step 2 Prepare data

All data required for operation available globally (either new datasets or datasets homogenized from existing sources).

>140 maps required

If you have better data for a site you can use those instead

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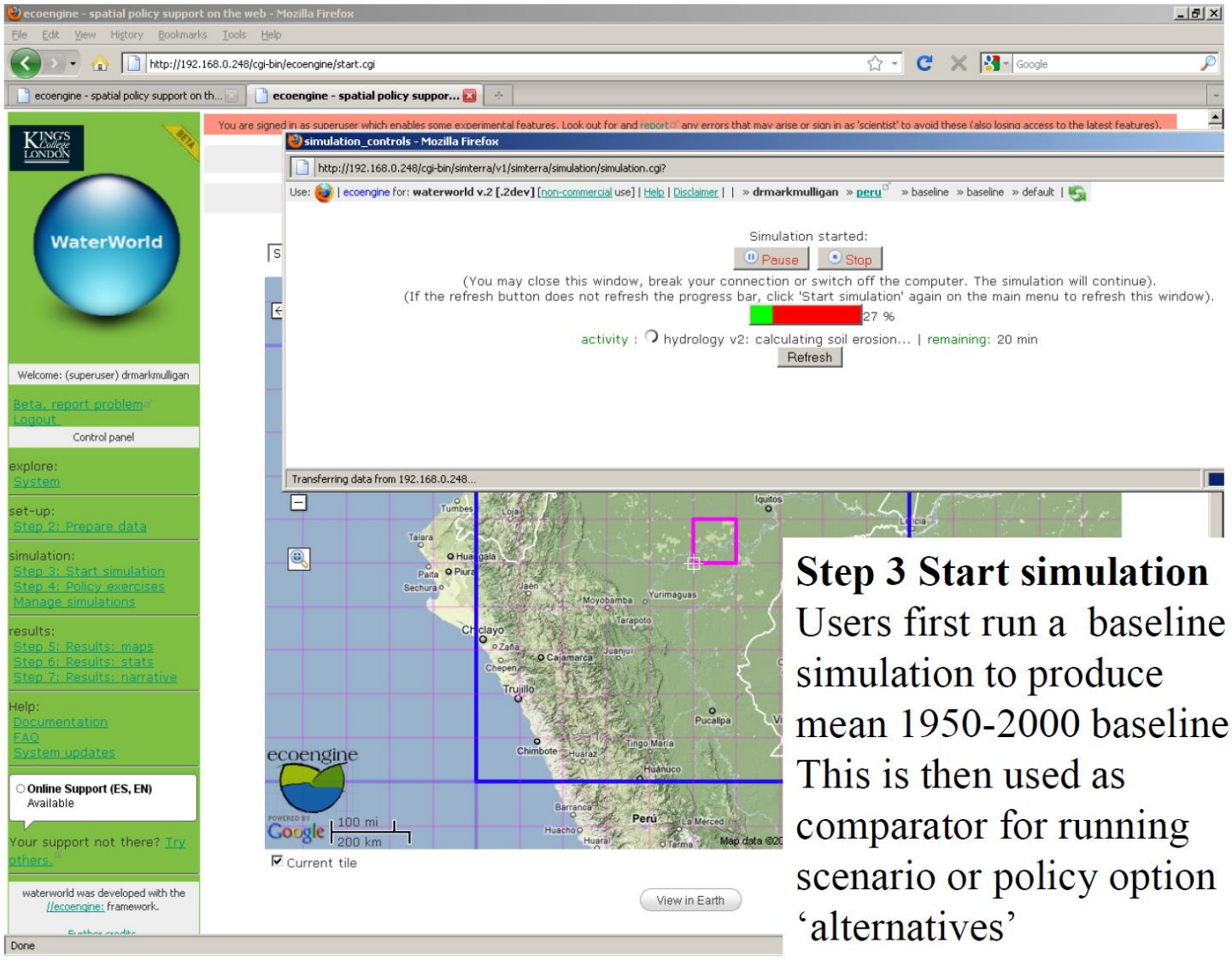

Step 3 Start simulation

Users first run a baseline simulation to produce mean 1950-2000 baseline. This is then used as comparator for running scenario or policy option 'alternatives'

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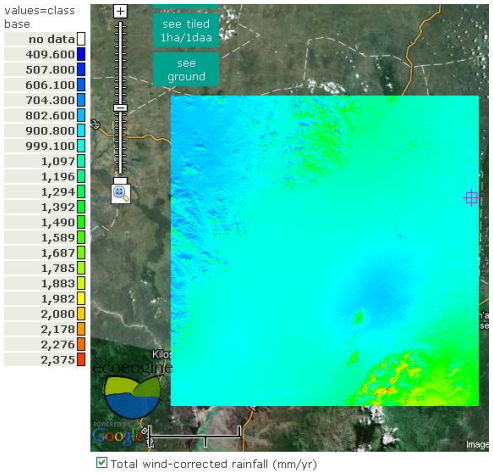
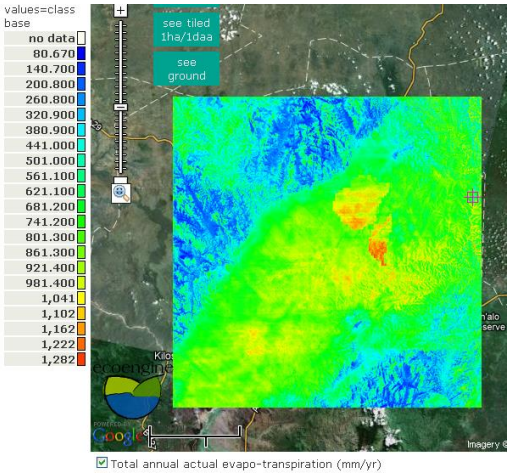
Key outputs: Hydrology

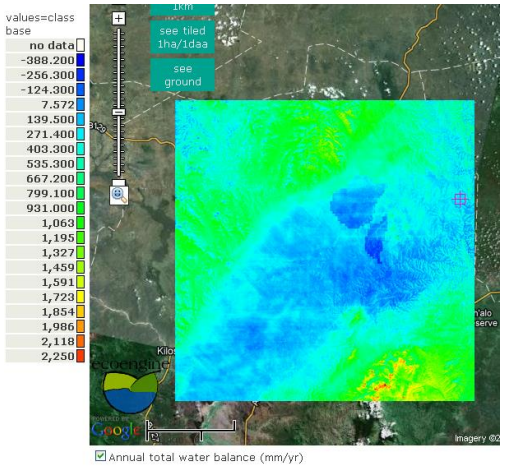
- Process based spatial hydrological model



Wind driven precipitation (based on WorldClim)



Actual evapo-transpiration



Pixel based water balance (Prec – ActEvap + Fog inputs)

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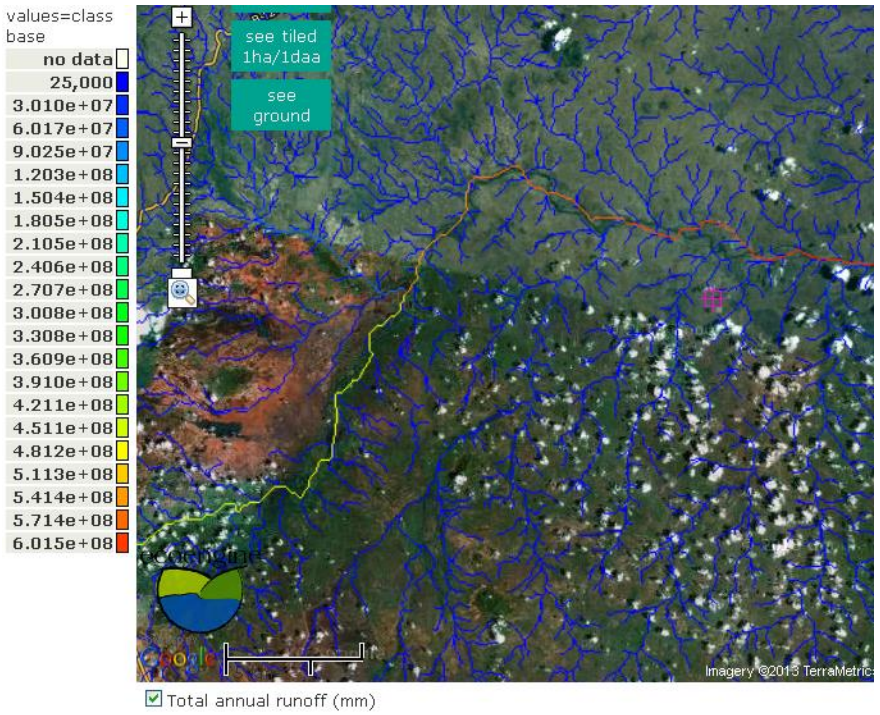
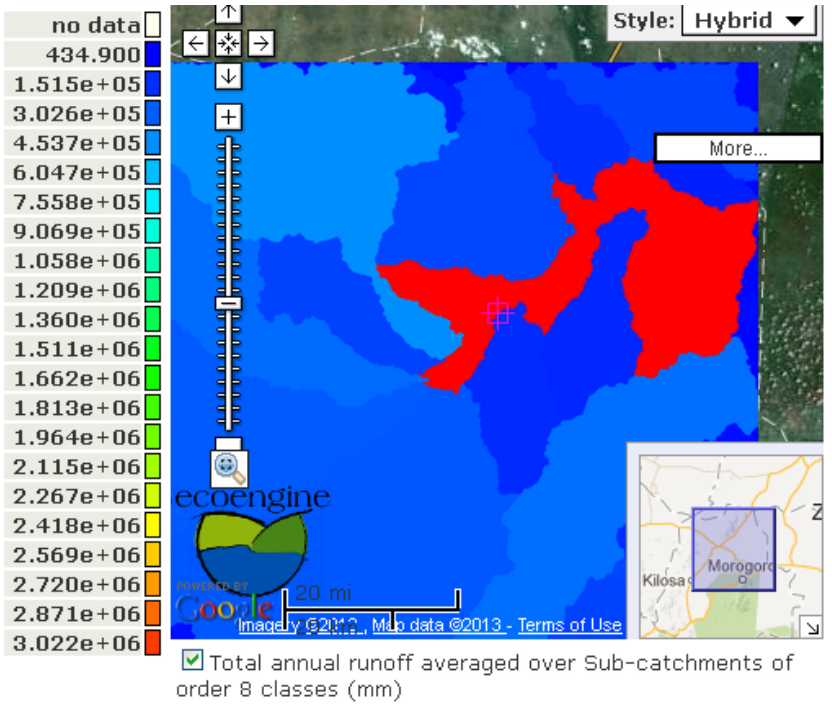
Key outputs: Hydrology



Annual runoff



Runoff (water yield) averaged by sub-catchments

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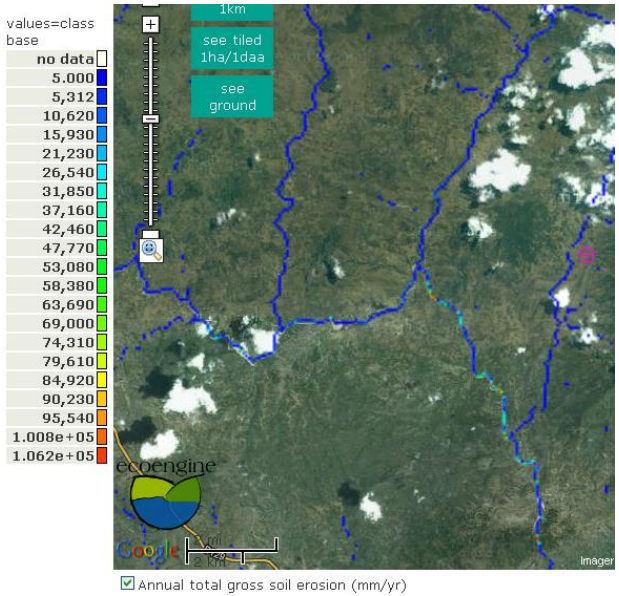
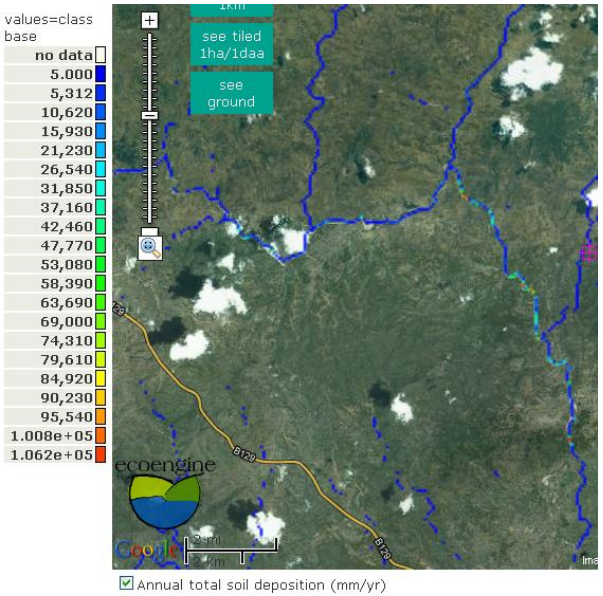
Key outputs: Soil erosion

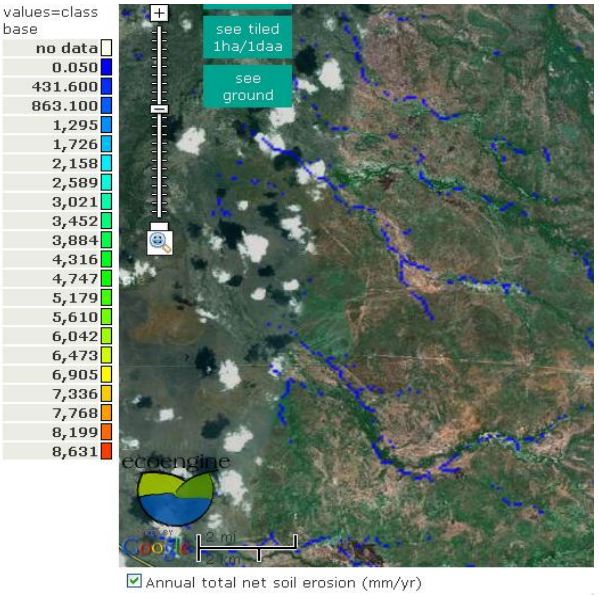
Full wash erosion model



Gross soil erosion: detachment of soil based on runoff, vegetation, slope

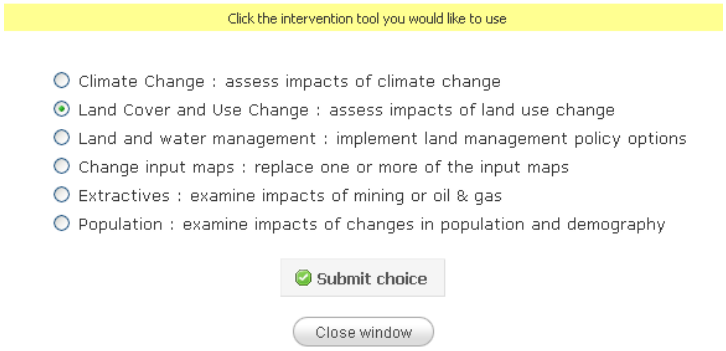


Soil deposition: detached soil that gets deposited

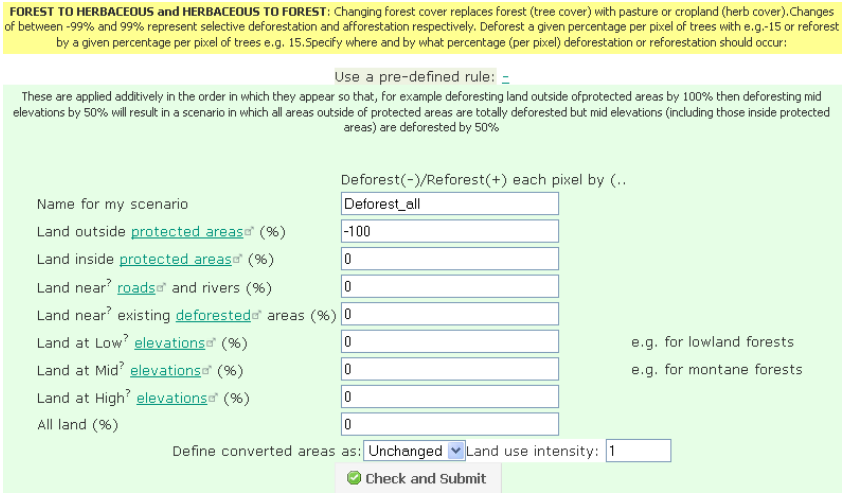


Net soil erosion

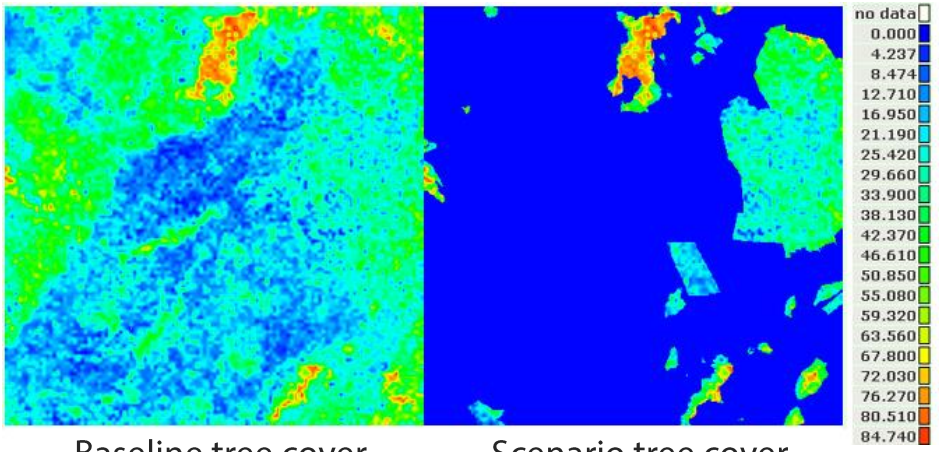
Scenarios



Scenarios for Climate Change and Land cover and use available



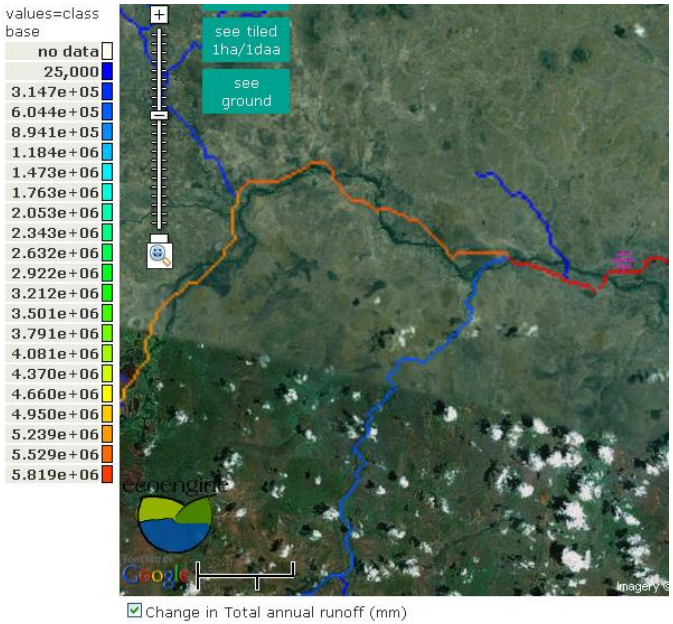
For example deforest all land outside PAs



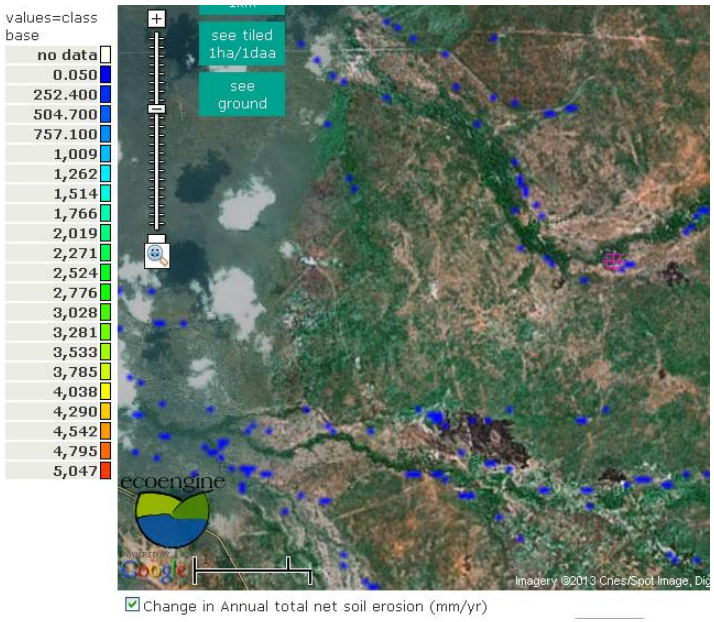
Baseline tree cover Scenario tree cover

Run scenarios

Results deforestation outside protected areas scenario



Deforestation leads to increased runoff (less water use by trees)



And increased erosion mainly visible around channels which leads to increased sedimentation

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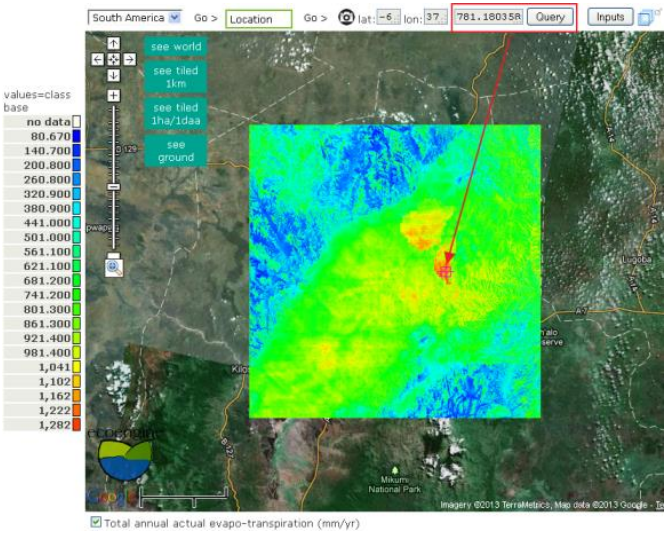
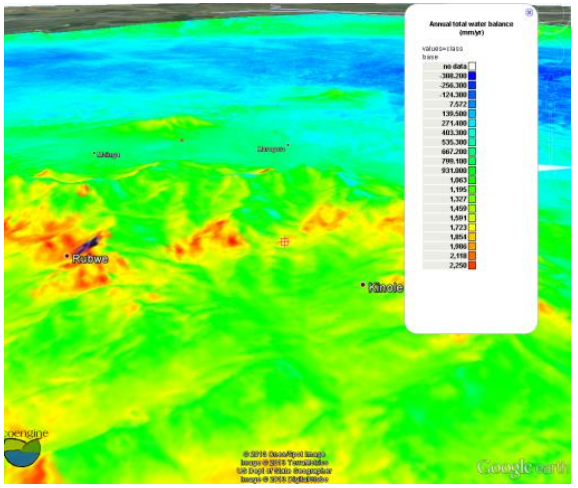
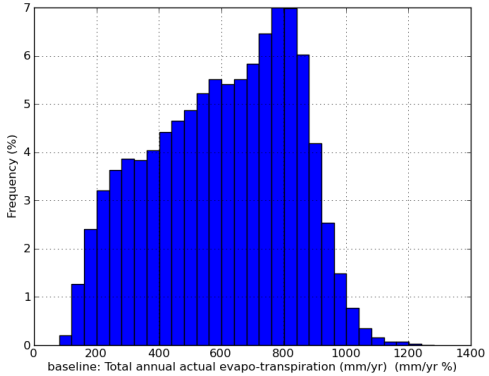
Analyse, visualise and/or download GIS maps



View in Google maps and query map at points



Overlay in Google Earth



Analyse map histogram

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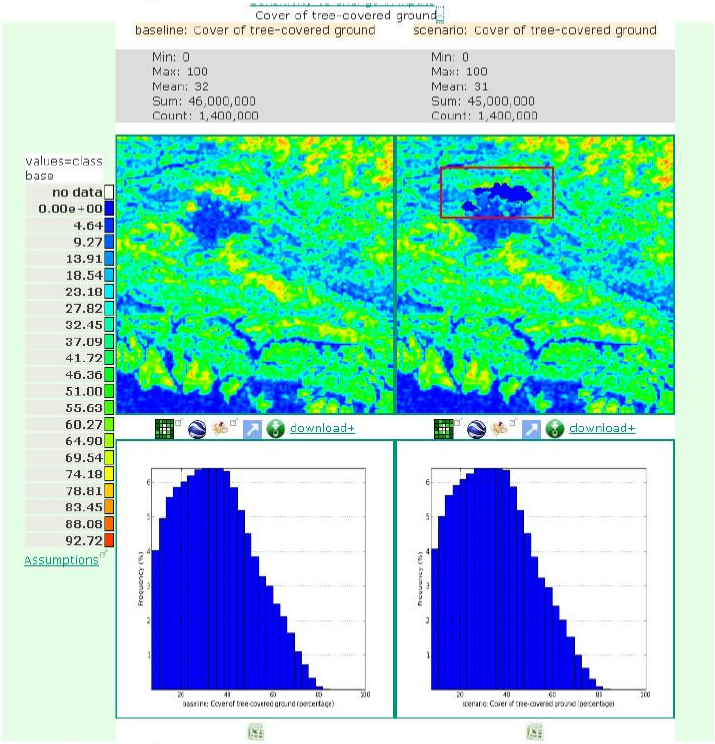
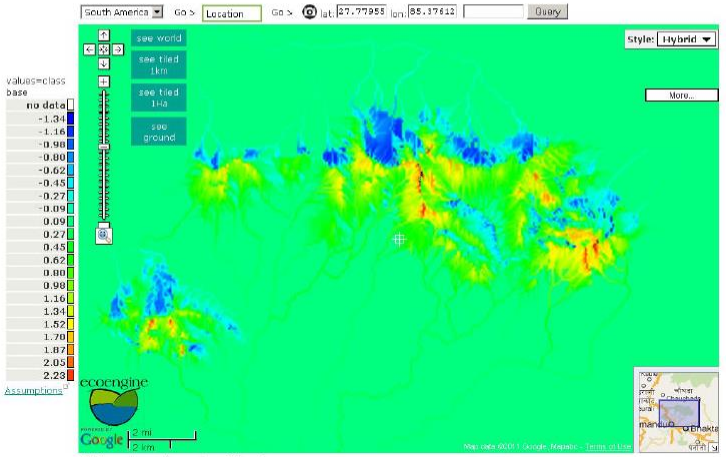
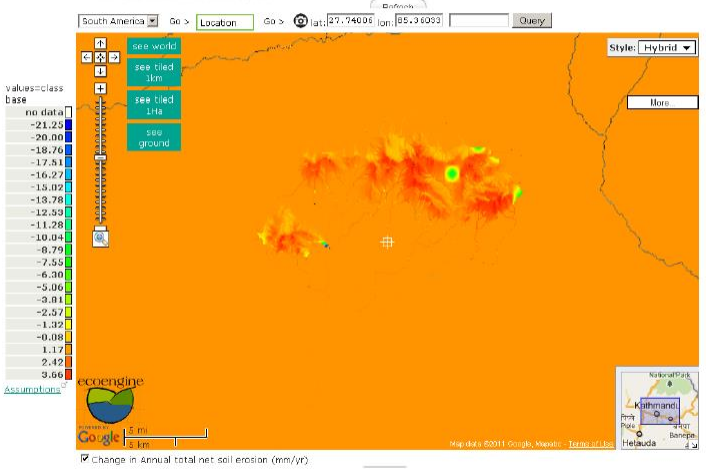
WaterWorld – case studies

Shivapuri, Nepal – Deforestation of IBA







Deforested protected area and replaced with herbaceous cover. Results in decreases in water on the forested cloudy N slopes but increases in the already sparse S slopes (towards Kathmandu). Impacts on erosion also variable

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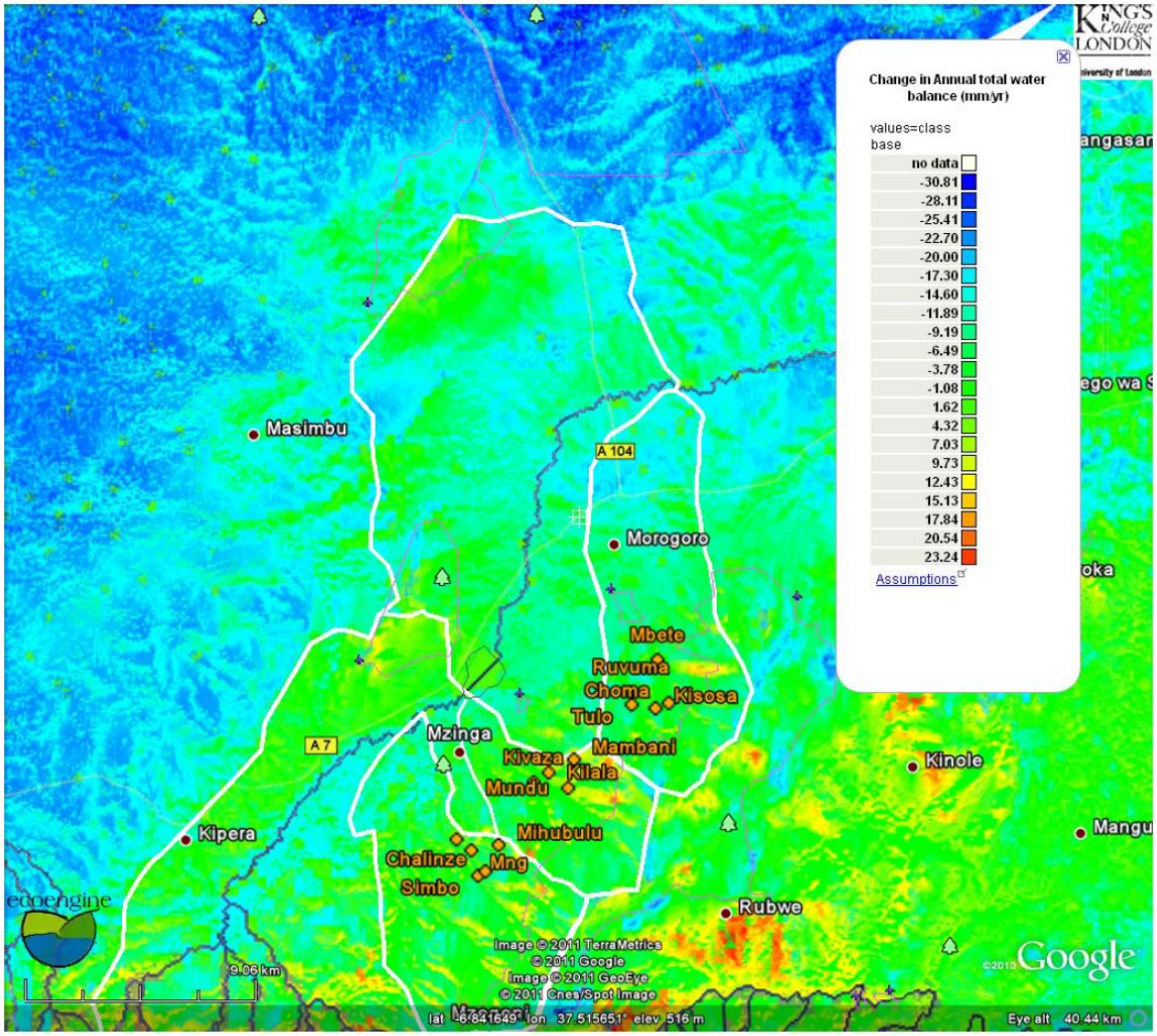
Ulugurus – Sensitivity to deforestation



Where to afforest with 10% woodlots to increase water flows.

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Limitations

- Provides estimates of hydrology per pixel, for erosion especially, local (sub-pixel) level characteristics can have a large impact
- Uses global datasets and assumptions which are not calibrated locally
- If your catchment crosses two tiles you need to run both separately and stitch a GIS software.
- You run on WaterWorld's servers so only a limited number of simulations can be stored. *Download results and delete simulation to start a new one*

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Thank you!

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