ECOSYSTEM SERVICE MODELS

Calculating and Aggregating Benefits from GDEs

Overview

Developed in ArcGIS's ModelBuilder, these three models create the final data used to quantify and visualize pollination, climate regulation, and water quality ecosystem services.

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Pollination

The pollination model finds the total area of pollinator dependent cropland in each basin, as well as the total area of cropland within 1km of a GDE.

Phases

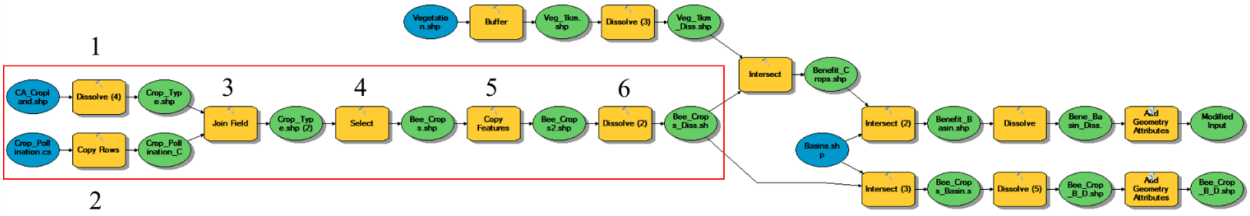
1. Extract pollinator dependent cropland
2. Extract pollinator dependent cropland near vegetative GDEs (benefitting land)
3. Aggregate pollinator dependent cropland by basin
4. Aggregate benefitting land by basin

Data Requirements

Title	Format	Purpose	Source
Crop_Pollination	csv	Designate pollinator dependent crop types	Manually compiled from Chaplin-Kramer 2014
CA_Cropland	shp	Spatial file of where crop types are grown in California	CADWR
Vegetation	shp	Vegetation iGDE layer from DWR. All features are assumed to support pollinator habitat	CADWR
Basins	shp	Feature for each groundwater basin. Used to aggregate services by basin	CADWR

Phase I

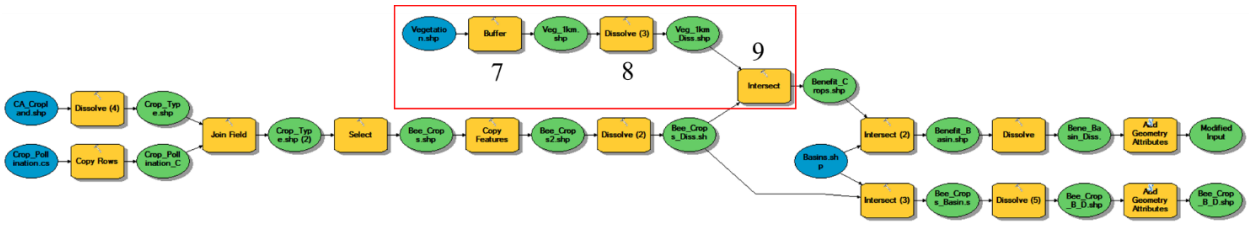
The first phase of the model takes CA_Cropland, a shapefile of all cropland in California, and links it to Crop_Pollination, a table containing information that designates whether each crop type is pollinator dependent. It then creates a new file, Bee_Crop_Diss, that only contains only pollinator dependent cropland.



Step	Input	Output	Tool	Purpose
1	CA_Cropland	Crop_Type	Dissolve	Combine features of the same crop type into a single feature
2	Crop_Pollination	Crop_Pollination	Copy Rows	Add OID column so that Crop_Pollination can be joined with cropland data. Keep the output location as your default geodatabase.
3	Crop_Type Crop_Pollination	Crop_Type	Join Field	Join columns identifying which crop types are pollinator dependent with the file containing the spatial locations of those crop types
4	Crop_Type	Bee_Crops	Select	Select the crops that are pollinator dependent. (Designated as "Pollinat_1" = 'y')
5	Bee_Crops	Bee_Crops2	Copy Features	Take the selected features and export them into a new file
6	Bee_Crops2	Bee_Crops_Diss	Dissolve	Combine all features into a single feature

Phase II

Find areas where pollinator dependent cropland is within 1km of vegetative GDEs. These areas are put into a new file, Benefit_Crops.



Step	Input	Output	Tool	Purpose
7	Vegetation	Veg_1km	Buffer	Create a 1km buffer around all features
8	Veg_1km	Veg_1km_Diss	Dissolve	Combine all features into a single feature
9	Bee_Crops_Diss Veg_1km_Diss	Benefit_Crops	Intersect	Extract areas of pollinator dependent cropland that are within the 1km vegetation radius

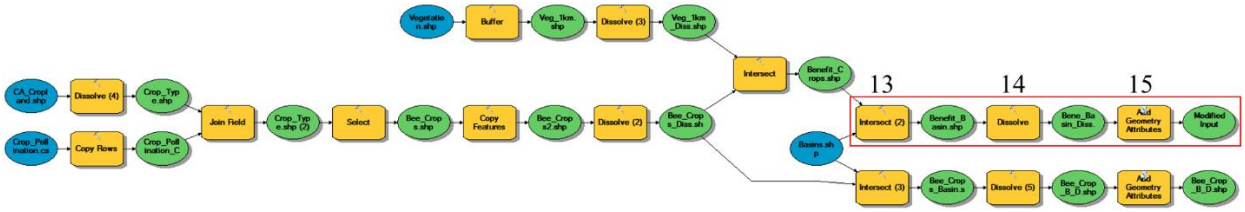
Phase III

Aggregate the areas of pollinator dependent cropland by basin.

Step	Input	Output	Total	Purpose
10	Basins Bee_Crops_Diss	Bee_Crops_Basin	Intersect	Assign pollinator dependent cropland to the corresponding basin
11	Bee_Crops_Basin	Bee_Crop_B_D	Dissolve	Create a single feature of the pollinator dependent cropland in each basin
12	Bee_Crop_B_D	Bee_Crop_B_D	Add Geometry Attributes	Adds a field containing the total square km of each feature

Phase IV

Aggregate the areas of cropland that could potentially benefit from GDE pollinators by basin.



Step	Input	Output	Total	Purpose
13	Basins Benefit_Crops	Benefit_Basin	Intersect	Assign pollinator dependent cropland that is within the 1km buffer to the corresponding basin
14	Benefit_Basin	Bene_Basin_Diss	Dissolve	Create a single feature of the benefitting cropland in each basin
15	Bene_Basin_Diss	Bene_Basin_Diss	Add Geometry Attributes	Adds a field containing the total square km of each feature

Climate Regulation

This model calculates the total CO2 storage in GDEs and in all areas within each basin that are not GDEs. To do this, we add together total above and below ground storage and separate GDEs from non-GDEs. We then total the final quantities in each basin.

Phases

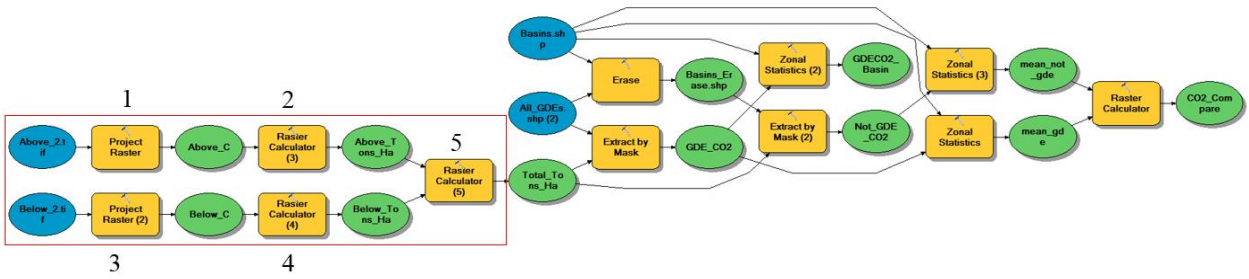
1. Create CO2 storage raster for the full state
2. Extract total GDE CO2 storage by basin
3. Calculate mean tonnes/ha CO2 storage in GDEs and non-GDEs by basin, and find the ratio of GDE to non-GDE efficiency

Data Requirements

Title	Format	Purpose	Source
Above	tiff	Above ground carbon storage	TNC
Below	tiff	Below ground carbon storage	TNC
Basins	shp	Define areas to aggregate data	CADWR
All_GDEs	shp	Location of all GDEs in Wetland and Vegetation datasets	CADWR

Phase I

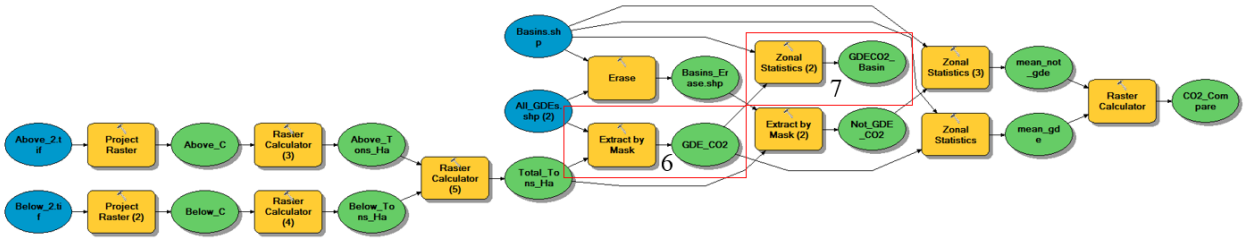
Convert each of raster pixels to CO2 tonnes/ha. It then adds below and above ground data together.



Process	Input	Output	Tool	Purpose
1	Above	Above_C	Project Raster	Project raster to match the GDE data: NAD_1983_California_Teale_Albers
2	Above_C	Above_Tons_Ha	Raster Calculator	Multiply the value of each pixel by 3.67 to convert C to CO2 "%Above_C%"*3.67
3	Below	Below_C	Project	Project raster to match the GDE data: NAD_1983_California_Teale_Albers
4	Below_C	Below_Tons_Ha	Raster Calculator	Multiply the value of each pixel by 3.67 to convert C to CO2, multiply by 0.01 to convert g/m to tonnes/ha "%Below_C%" * 0.01*3.67
5	Below_Tons_Ha Above_Tons_Ha	Total_Tons_Ha	Raster Calculator	Add above ground and below ground CO2 together

Phase II

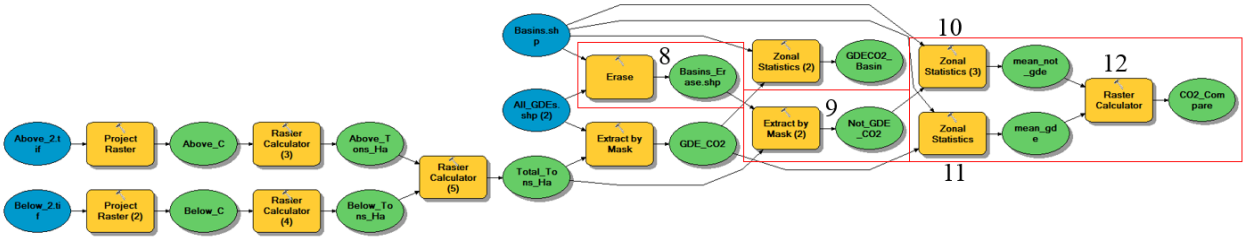
Overlay CO2 data with the locations of GDEs. Extract and add together CO2 pixels in GDE areas in each basin.



Process	Input	Output	Tool	Purpose
6	Total_Tons_Ha All_GDEs	GDE_CO2	Extract by Mask	Extract pixels that are in GDE areas
7	GDE_CO2 Basins	mean_gde	Zonal Statistics	Calculate mean tonnes/ha of CO2 in each basin for GDE areas

Phase III

Because each pixel is one hectare in size, the mean CO2 tonnes/ha can be calculated by finding the mean pixel value in GDE and non-GDE locations in each basin. In order to compare the climate regulation efficiency of GDEs versus non-GDEs, the mean tonnes/ha for non-GDEs is divided by the mean tonnes/ha for GDEs.



Process	Input	Output	Tool	Purpose
8	All_GDEs Basins	Basins_Erase	Erase	Create a shapefile that contains all areas in each basin that do not overlap with GDEs
9	Basins_Erase Total_Tons_Ha	Not_GDE_CO2	Extract by Mask	Extract pixels that are not in GDE areas
10	Basins GDE_CO2	GDECO2_Basin	Zonal Statistics	Calculate total tonnes of CO2 in GDE areas for each basin
11	Basins Not_GDE_CO2	mean_not_gde	Zonal Statistics	Calculate mean tonnes/ha of CO2 in each basin for non-GDE areas
12	mean_not_gde mean_gde	CO2_Compare	Raster Calculator	Find the ratio of mean GDE to non-GDE tonnes/ha in each basin

Water Quality Regulation

This model calculates the total area of GDEs in each basin that have the potential to purify polluted water before it enters a body of water.

Phases

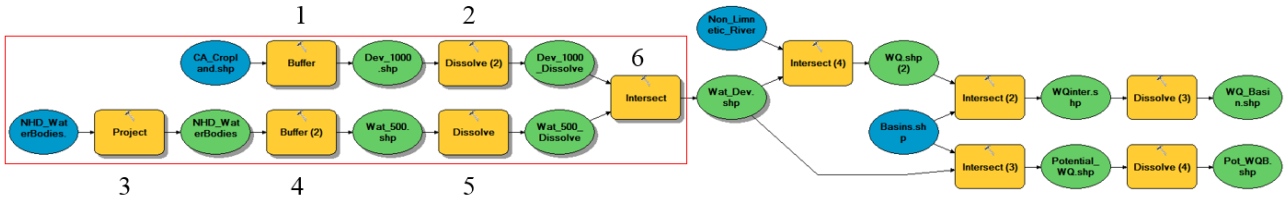
1. Find regions of most importance for filtering polluted water.
2. For each basin, find total area of GDEs in the targeted areas.
3. For each basin, find total targeted area.

Data Requirements

Title	Format	Purpose	Source
CA_Cropland	shp	Contains all developed (urban and cropland) land cover	CADWR
NHD_WaterBodies	shp	All surface water in California (extracted NHD StreamRiver, LakePond, and Reservoir features)	NHD
Non_Limnetic_Riverine	shp	All GDEs that are not limnetic or riverine (ones that have water filtering capabilities)	CADWR
Basins	shp	All groundwater basins in California	CADWR

Phase I

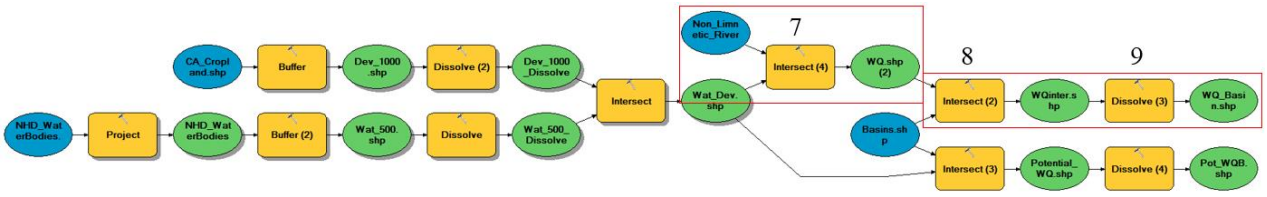
Create a 1000m buffer around developed areas (urban and cropland), and create a 500m buffer around all GDEs except open water. Extract the regions where these two buffers intersect.



Process	Input	Output	Tool	Purpose
1	CA_Cropland	Dev_1000	Buffer	Create a 1km buffer around all developed/cropland land cover
2	Dev_1000	Dev_1000_Dissolve	Dissolve	Dissolve all buffered features into a single feature
3	NHD_Waterbodies	NHD_WaterBodies	Project	Project raster to match the GDE data: NAD_1983_California_Teale_Albers
4	NHD_WaterBodies	Wat_500	Buffer	Create a 500m buffer around all bodies of water
5	Wat_500	Wat_500_Dissolve	Dissolve	Dissolve all buffered features into a single feature
6	Wat_500 Dev_1000_Dissolve	Wat_Dev	Intersect	Extract areas where buffered developed land overlaps with buffered water bodies

Phase II

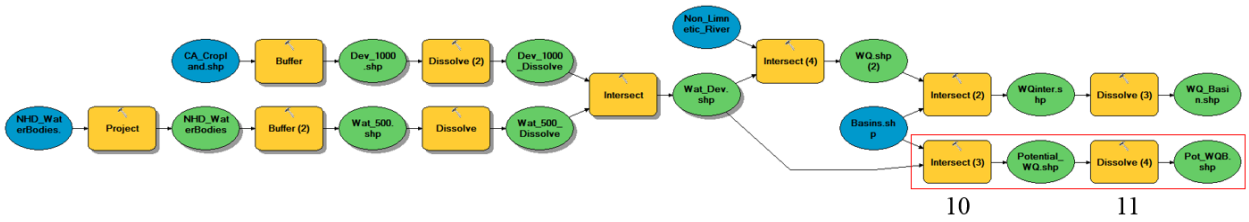
Extract GDEs that are inside the regions extracted in Phase I. Aggregate GDEs to find total area of potential water quality regulation in each basin.



Process	Input	Output	Tool	Purpose
7	Non_Limnetic_Riveri Wat_Dev	Non_Limnetic_Riveri	Select Layer By Location	Select all GDEs that at are at least partially within Wat_Dev
8	WQ Basins	WQ_Inter	Intersect	Separate GDEs into their corresponding basins
9	WQ_Inter	WQ_Basin	Dissolve	Aggregate GDEs that are in the same basin

Phase III

By basin, calculate total area of the regions extracted in Phase I to find the total area in each basin that would benefit from having natural land cover to filter water.



Process	Input	Output	Tool	Purpose
10	Basins Wat_Dev	Potential_WQ	Intersect	Separate potential areas of water quality service into their corresponding basins
11	Potential_WQ	Pot_WQB	Dissolve	Aggregate potential areas of WQ service by basin