Mapping Water Purification Scenarios of Dawei - Kanchanaburi Superhighway Area with InVest toolset.

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ABSTRACT

Scenarios are processes to reveal stories which can explain possible circumstances of the coming future. They explore the possibility and alternative solutions of difficult to explain unexpected and uncertain situations, which might or might not happen in the future. This study creates water purification services of the landscape along the proposed Dawei - Kanchanaburi superhighway. We applied the Scenario tool, which is included in InVEST toolset. The scenarios were developed using the parameter closed to the reality. The results derived from the water purification model represented interesting information, including volume of nutrient retention in each sub-watershed and volumes of nutrient that are released to the downstream of its sub-watershed. This study can be the reliable experiment of GIS application Ideas.

Keywords: *Scenarios, water purification, Ecosystem services, InVest, Nutrient retention.*

1. INTRODUCTIONS

Water purification services as according to special character of Ecosystem services. As state on main details of Ecosystem services, include: provision of clean air and water; maintenance of soil fertility and structure; maintenance of live able climates; pollination of crops and other vegetation; control of the vast majority of potential pests, diseases and weeds; provision of genetic resources; production of goods like food and fiber; and provision of cultural, spiritual and intellectual values (Daily, 1997; Al-Kodmany et al. 2001).

Fisher et al (2009) propose that ecosystem services are the aspects of ecosystems utilized (actively or passively) to produce human well-being. The key points are that 1) services must be ecological phenomena and 2) that they do not have to be directly utilized. Defined this way, ecosystem services include ecosystem organization or structure as well as process and/or functions if they are consumed or utilized by humanity either directly or indirectly.

From a special meeting of ASEAN Foreign Ministers held in Singapore on May 19, 2008, the Thai and Burmese foreign ministers signed a memorandum of understanding (MOU) on the development of the Dawei deep-sea port project. The two countries agreed to construct the port, establish a road link from Dawei to Bangkok and to set up the Dawei-Kanchanaburi border crossing super highway area. This situation would make so many natural landscapes changing along the Thai – Burmese Road. Accordingly, the sequestration of water purification, also will be destroyed.

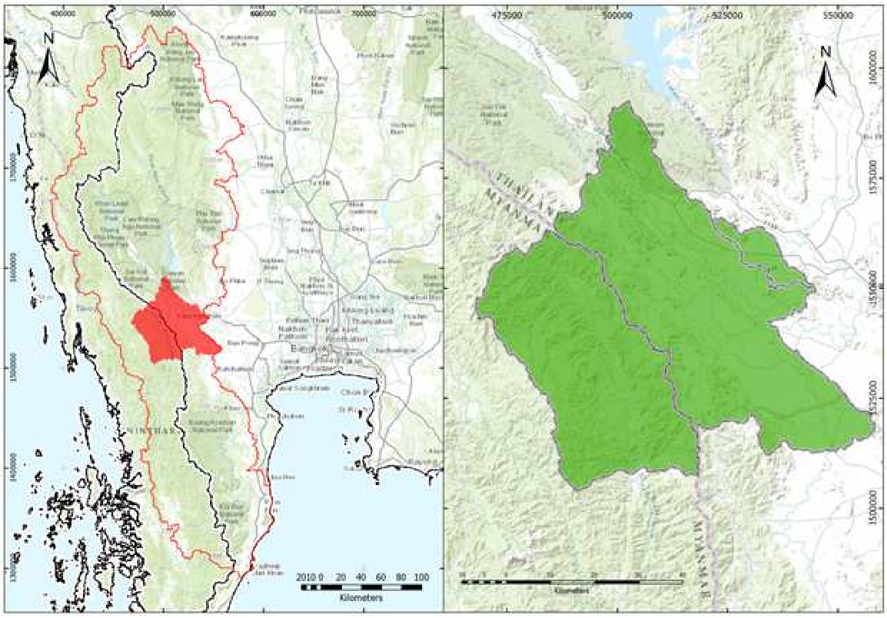


Figure 1. Study area: Dawei – Kanchanaburi, THAILAND.

2. DATA REQUIREMENT AND METHODS.

The InVest toolset involves the nutrient retention model which focuses on nitrogen and phosphorus retention in each land use/cover class, as the key topics of water purifications. Two key components are included: 1) the ability of vegetation and soils to avoid initial nutrient loss and 2) the ability of vegetation and soils to take up nutrients exported to the parcel from upstream parcels. The model is based on export coefficients derived from secondary data collected from field measures of how much nutrient leaves a farm field under average conditions of nutrient (fertilizer, plant-driven nitrogen) inputs, field management, slope and rainfall, and soil type.

2.1 Data requirement

In this section, all data for the nutrient retention model are included with 11 items, there are; 1) Digital elevation model (DEM), 2) Soil depth (required), 3) Plant Available Water Content, 4) Average Annual Potential Evapotranspiration, 5) Land use/land cover, 6. Watersheds, 7. Sub-watersheds, 8. Biophysical Table, 9. Threshold flow accumulation value, 10) Water Purification Valuation table, and 11) Water Purification threshold table.

2.2 Methods

a) Nutrient retention model procedure.

This stage is based on nutrient pollutant loadings. Pollutant loadings at parcel x with a given LULC category, polx, is based on export coefficients directly derived by associating a specific LULC category with a lookup table of corresponding export values (see USEPA; Gotaas 1956; Reckhow et al. 1980; Athayde et al. 1983). An example of export coefficient values of nitrogen and phosphorus as shown in table 1.

Table 1. USEPA export coefficient values for nitrogen and phosphorus

LULC	Nitrogen export coefficient (kg/ha/yr)	Phosphorus export coefficient (kg/ha/yr)
Feedlot or dairy	2,900.0	220.000
Business	13.8	3.000
Soybeans	12.5	4.600
Corn	11.1	2.000
Cotton	10.0	4.300
Residential	7.5	1.200
Small gain	5.3	1.500
Industrial	4.4	3.800
Idle	3.4	0.100
Pasture	3.1	0.100
Forest	1.8	0.011

b) Apply nutrient retention model to Land use & Land cover (LULC).

The nutrient retention model was applied to LULC in year 2012 to map the phosphorus load and the export-to-downstream map. Basically, the model uses water yield map from the last section to run the model. Two maps are generated from the model including phosphorus load and export maps both in pixel- and sub-watershed-levels (The InVEST guide notes claim that they only confidence in the interpretation of these models at the sub-watershed scale, so all outputs are summed and/or averaged to the sub-basin scale; for the pixel level map is used for visualization purpose only).

c) Applied the Scenario tool, as included in InVEST toolset.

The tool focuses on changes of features in land use/land cover map based on giving predefined model parameters. All barriers and obstacles of changes can be determined to model; the model uses them as a part of the simulation process. Results from scenario tool are new maps, which represent new landscape based on scenarios.

3. RESULTS AND DISCUSSION.

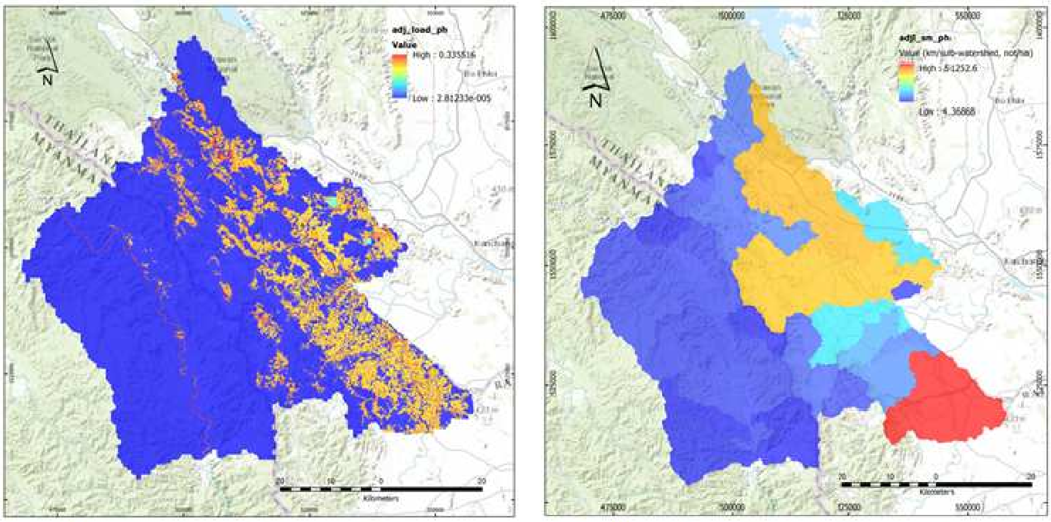
3.1 Nutrient retention model results.

Based on quantity of phosphorus in each sub-watershed and capability to retain the nutrient of each LULC class, the sub-watershed in the south of the study area (code 8019 in

Table 2) was the one that had the largest amount of phosphorus exported to the stream. Theoretically, the streams in sub-watershed id: 8019, 8006 and 8009 should be highly contaminated from the nutrient, which need to be cleaned.

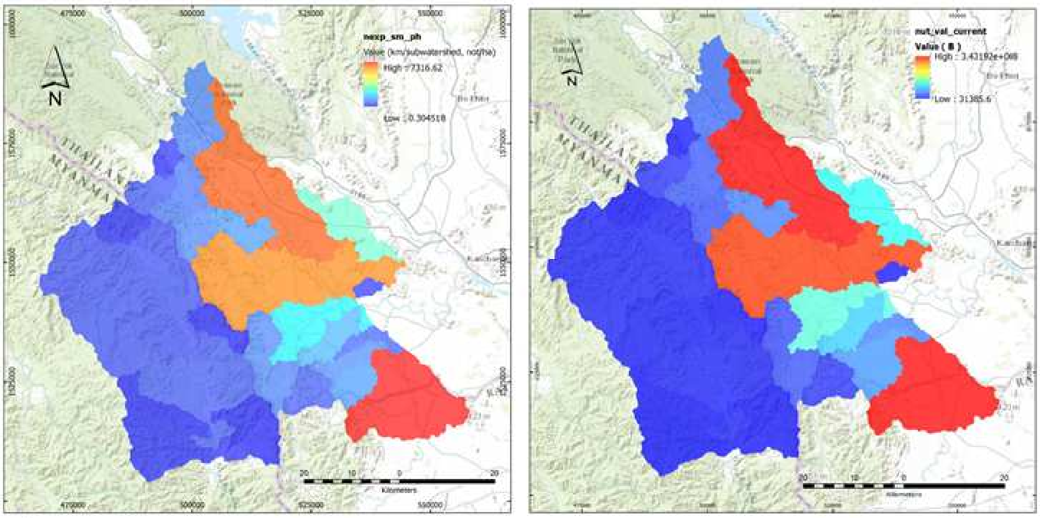
Fig. 2a and b, illustrate pixel-based and sub-watershed-based results respectively of phosphorus loading all over the landscape. Mostly, the density of pollutant loading is across the east side of the study area. We could observe more intense phosphorus in the agricultural area, and we found lessen in the forestry area in the west part of the study area.

This model also generated a map which represents the nutrient that exported to downstream outlets of each sub-watershed (Fig. 3a and b).



a) Current phosphorus load map (pixel level) *b) Current phosphorus load map (sub-watershed level)*

Figure 2. Current phosphorus load map.



a) Current phosphorus exported to stream map (sub-watershed level) *b) Value of the sub-watershed landscape for retaining nutrient over 15 years*

Figure 3. Current phosphorus exported to stream map.

3.2 Results of scenario.

Fig. 4 illustrates the pixel-based result of phosphorus loading all over the landscape. Mostly, the density of pollutant loading is across the east side of the study area. We could observe more intense phosphorus in the agricultural area, and we found lessen in the forestry area in the west part of the study area.

The model also generated a map which represents the nutrient that exported to downstream outlets of each sub-watershed (Fig. 5). The results of the scenarios obviously represent the changes in land use would cause changes of the overall nutrient loading in each sub-watershed. Compare to other routes, route A was the route that had most impact to the water quality in the area as we can see from the quantity of nutrient export to the stream.

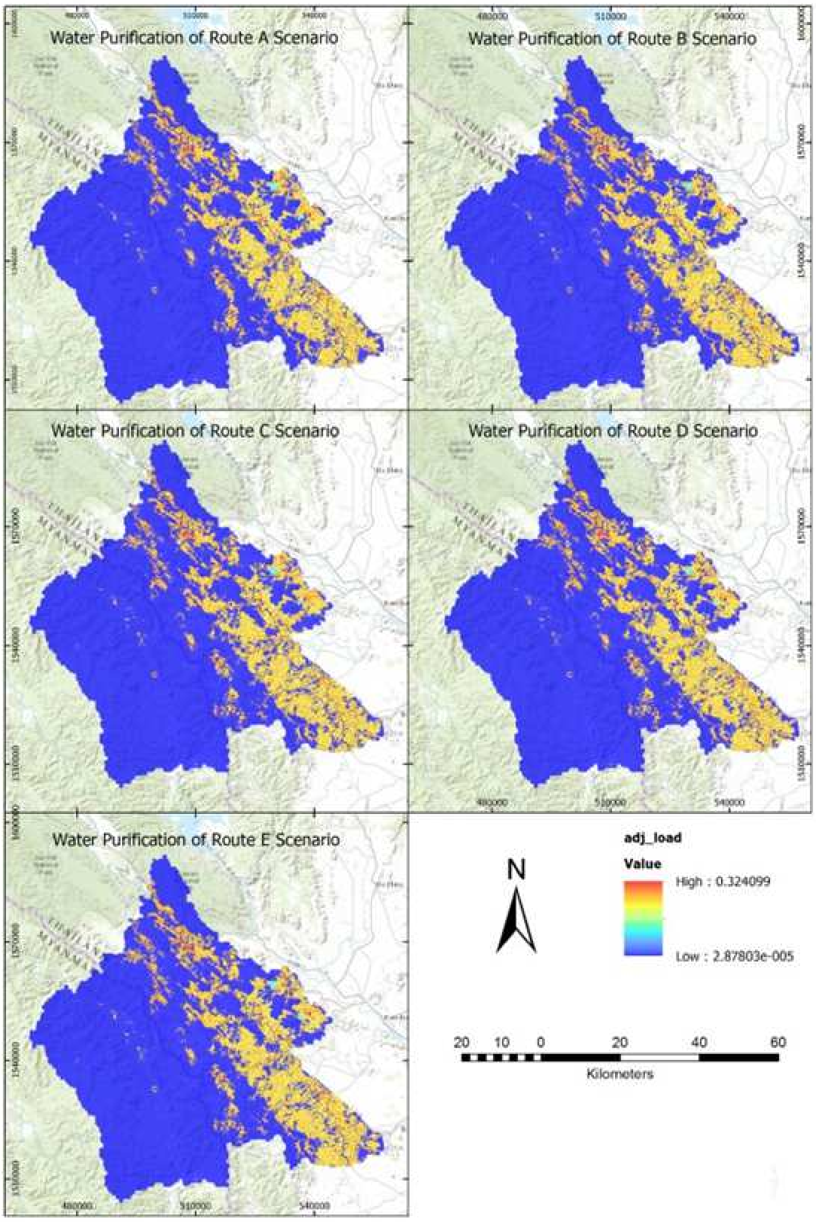


Figure 4 Nutrient adjusted load maps for all 5 scenario landscapes

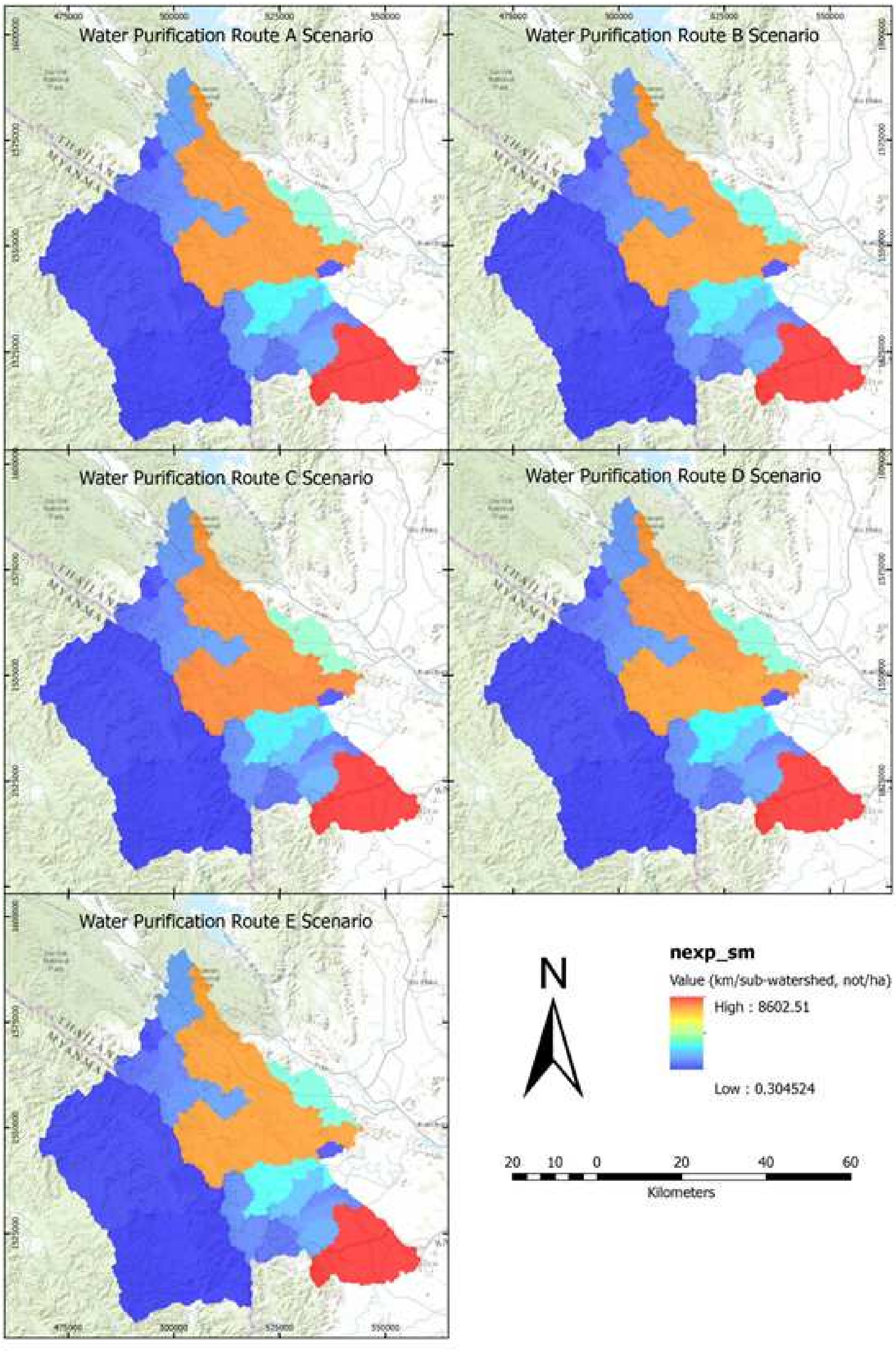


Figure 5. Nutrient exporting to stream maps for all 5 scenario landscapes

4. CONCLUSIONS.

Scenario-based model is one of the most advantageous models which can project or predict any situations that might happen in the future. The results derived from the water purification model represented interesting information, including volume of nutrient retention in each sub-watershed and volumes of nutrient that are released to the downstream of its sub-watershed. This landscape could preserve nutrient (but might be the problem in environment) approximately 41,246.07 kg. per year for free and released some nutrient to the outlet for 201,456.4 kg. per year (counting from each sub-watershed in the area).

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