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SESSION 05 Enhancement of Multi-Use Landscapes

Landuse impacts on the drinking water reservoir of a straightened mountain river – an initial GIS-based survey

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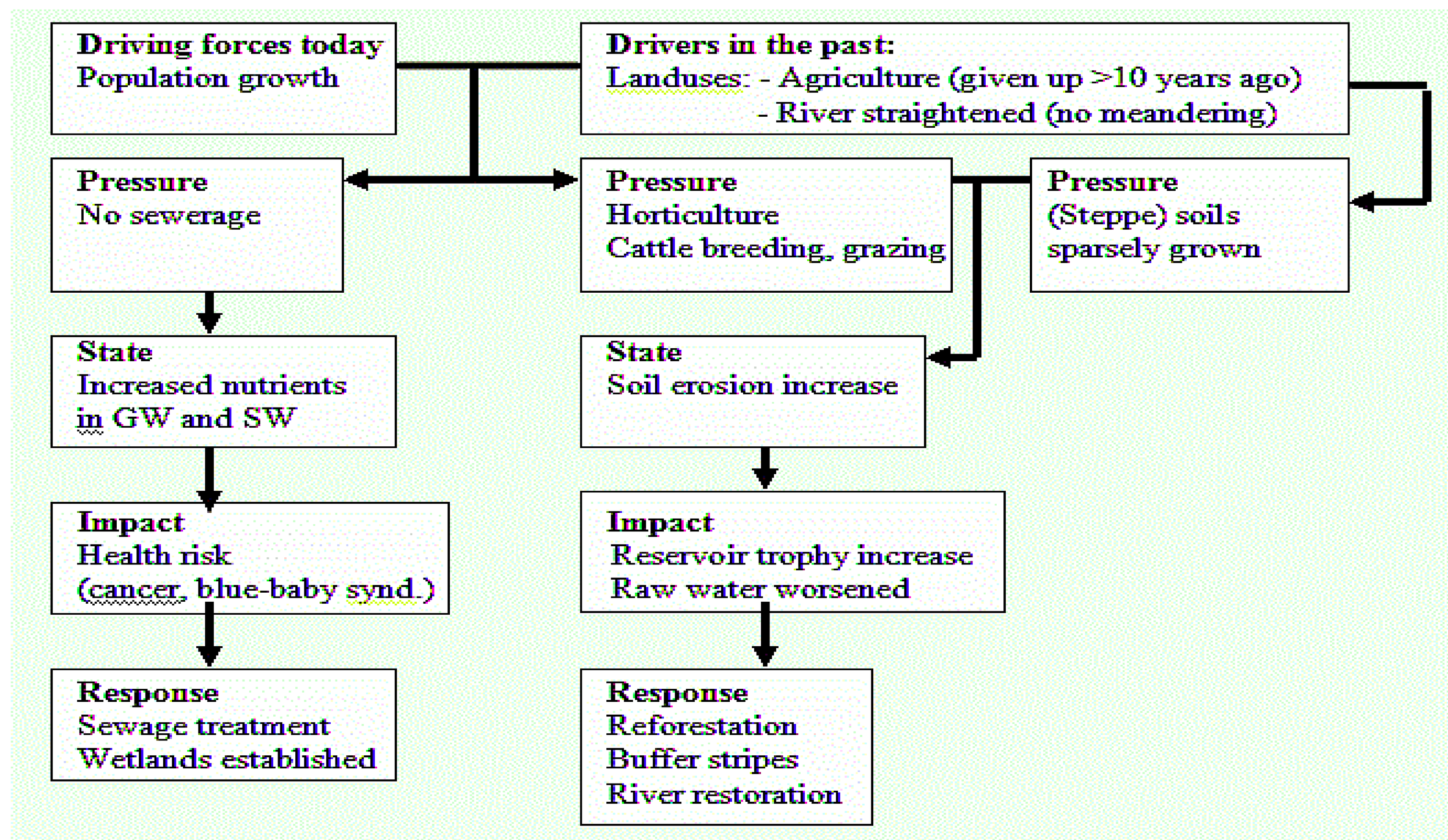
Abstract
The poster presents the results of a study that was carried out in the basin of the upper Salgir River in the southern part of the Autonomous Republic Crimea, Ukraine. The reason was related to the observation that the reservoir (coloured red in Fig. 2) just downstream of the basin outlet showed obvious signs of eutrophication like a strong smell of rotten eggs in water withdrawn from the hypolimnion. Among others, the reservoir is used for drinking water supply to the southern part of the Crimean capital Simferopol.
At a closer look it turned out that the main environmental pressures in the basin are related to the creation of new settlements. For this purpose, the river has been straightened decades ago. Thereafter, agriculture was given up nearly completely.
The present situation includes tendencies that have improved and others that worsened the ecological state of the river basin. GIS-based modelling can help to better understand the consequences by simulation of different scenarios of landuses like decrease or increase of urbanisation or agriculture activities. First results in this direction have already be gained but more practical monitoring will be required to achieve final conclusions

I. INTRODUCTION

The studied part of the Salgir River basin comprises an area of 27,288 ha situated in the karst region of the northern slopes of the Crimean Mountains and their forelands (maximal elevation: 1447 m+MSL (Mean Sea Level), minimal elevation 294 m+MSL. The area is mainly covered by forests and vegetation comparable to steppe sparsely growing on red-brown mountain soils (partly former agricultural areas) (fig. 1-4).
The bed of the river has been straightened and transposed (Sadikova 2002) (fig. 3) to create space for further urbanisation and reduce the risk of flooding. The new residential areas develop in the floodplain that is covered by alluvial soils. Still today, new houses are going to be constructed by the Tartar population in nearly the whole floodplain without recognisable urban landscape design, canalisation or other infrastructure. All these influences contribute to the pressures on water quantity and quality in the upper Salgir basin. A DPSIR analysis is presented below.



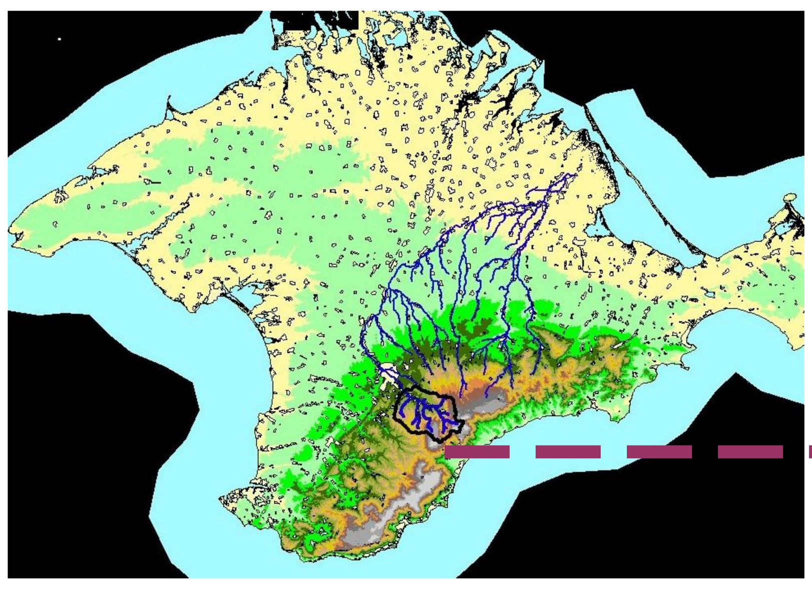


Fig. 1. Crimea and the River Salgir

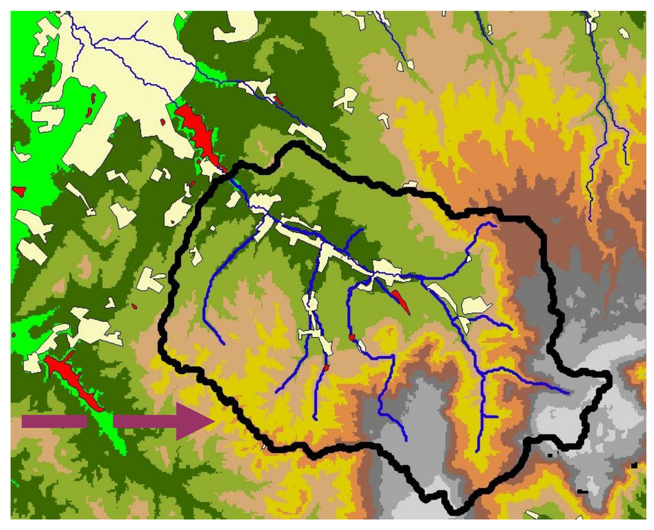


Fig. 2. Upper Salgir river basin

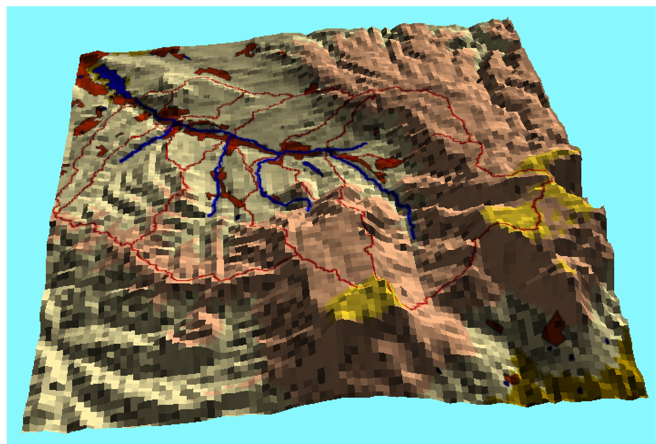


Fig. 3. The Salgir basin in 3-D view

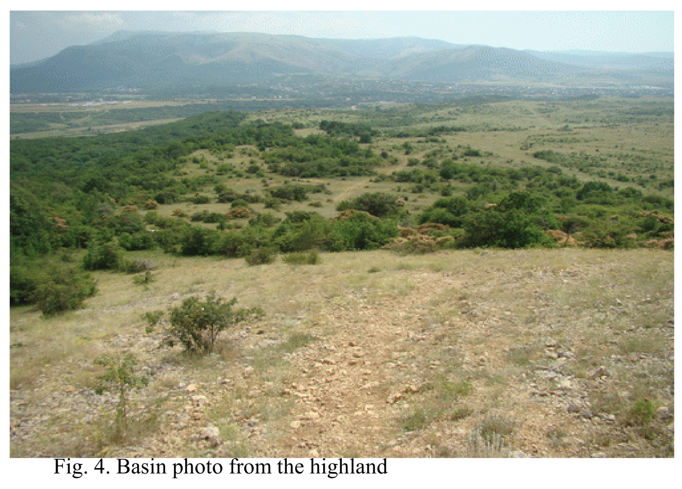


Fig. 4. Basin photo from the highland

II) METHODOLOGY

Workpackages

- Creation of a geo-database
- Mapping pollution sources and erosion risk areas
- Assessment of loads from settlements
- Calculation of average net erosion
- Estimation of river flow velocity and sediment transport
- Propositions for improvement to discuss with stakeholders

Table. Overview on used software, its purpose and creator

Term	Purpose	Creator
ArcView (AV 3.2a)	Basic GIS software	ESRI
Grid tools	DEM preparation, flow direction	Schaeuble (1995)
L-THIA-NPS GIS	SCS run-off curve number (CN), erosion risks	US-EPA
BAS	Rain drop path	AV GIS Basin 1 extension; Petras (2003)
AVerosion	Soil erosion (per pixel) based on MUSLE87 equation using the Multiple Flow Algorithm	Schaeuble (2005) based on Wishmeier & Smith (1978)
AVSWATx	Simulation of landuses, calculation of water quantity, quality and sediment yield	Arnolds et al. (1998)
Surface Tools v. 1.6	Slope of rivers	Jeness Enterprises (2005)
Web GIS-based VFSMOD System	Efficiency of filter strips (using MUSLE87)	Park (2009)

III) RESULTS

a) Assessment of loads from settlements located along the river

<u>Two calculation approaches</u> for phosphorous load
1) Emissions from settlement areas roughly 1-2 kg/ha*y (Loer 1974);
Living area –2000 ha (registered) + 1000 ha unregistered, = 3000 ha
Results: 8-16 kg/d
2) German waste water P standard value (Gujer 2006):
2-3 g/cap.*d
40000 inhabitants
Result: 80-120 kg/d; emission into the river 10-20% because of retention (degradation, filtration) = 8-24 kg/d

Expected Concentration:
Discharge Q avg. = 1-2 m3/s; example (avg.) 130 000 m3/d
P = 0.06-0.18 g/m3 or **0.1-0.2 mg/L**

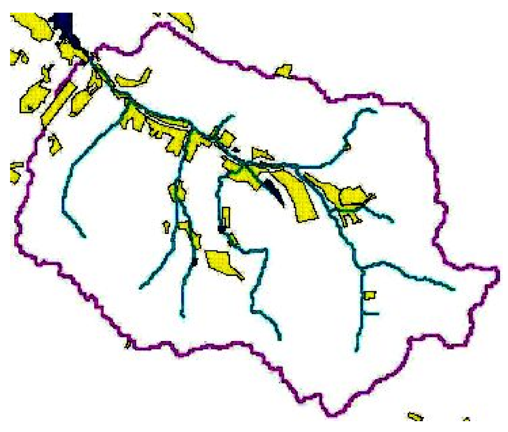


Fig. 5. Settlements along the river

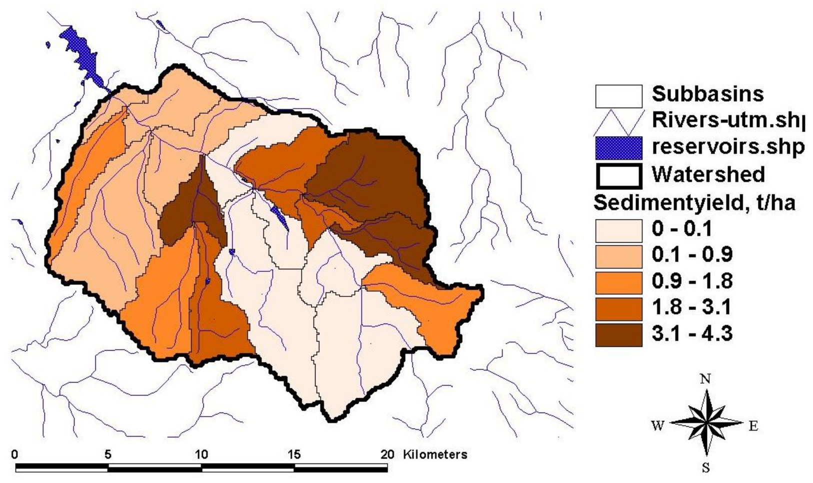


Fig. 6. Erosion calculated by SWAT

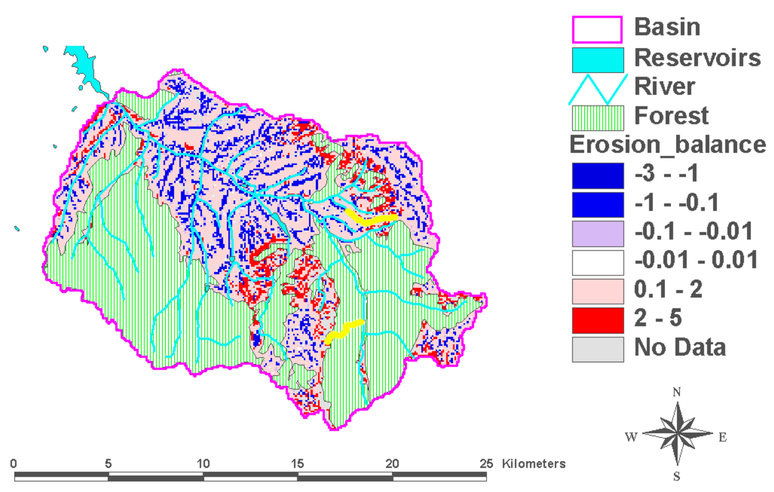


Fig. 7. Net erosion by AVerosion

b) Assessment of erosion risks

<u>Two alternative GIS modules are used</u> for calculation of erosion risks:
1) Model SWAT: erosion calculated based on CN (curve number) reported per subbasin
2) GIS Module AV erosion: calculation of erosion balance based on MUSLE87 reported per pixel

The exact freight of phosphorous (adsorbed to soil particles) was modelled but still needs to be calibrated.

IV-a) CONCLUSION

a) Urbanisation:

Figures for the P-load of groundwater from settlements in the floodplain just upstream of the reservoir are less alarming for the fast-flowing Salgir River but too high for lakes or reservoirs. Groundwater pollution was detected already 10 years ago (Sadikova (2002) and will be increasing.

Solutions for the sewage loads to discuss with stakeholders :
- Establish and enforce minimal requirements for sewage (septic tanks, sludge collection or bio-toilets)
-Connection of wetlands as groundwater filter

-Key stakeholders belong to the immigrating Tartar population who resettle their land after expulsion under the Stalin regime. They are unwilling to register their piece of land and houses according to Crimean legislation. Political solutions and peaceful cooperation are required including higher political levels.

IV-b) CONCLUSION

b) Soil erosion

In some basin areas erosion is still too high but could be reduced by plantings
Solutions to discuss with stakeholders
- Planting of buffer stripes and reforestation.
- **River restoration** (prolongation of river course, similar to the original state),
- Creation of wetlands and pre-impoundments

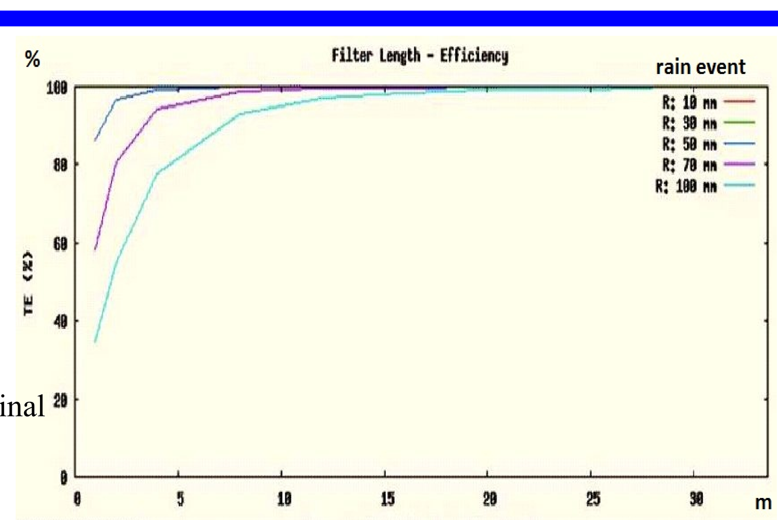


Fig. 8. Filter trap efficiency (Y: 0-100%, X:buffer width 0-30m) for storms 10-100 m (s. Park 2009)

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V) REFERENCES

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