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# Multisource data fusion for historic DEM creation to facilitate hydrological analysis of historical Maulbronn Monastery complex water system

In 1993, Maulbronn Monastery Complex has been enlisted on the World Heritage List of UNESCO. The justification for this enlistment was based not only on the Gothic Monastery buildings, but on the assessed completeness of the whole complex, including sophisticated water management system (see Figure 1) set up in 12th century by the Cistercian Order. Until today the system has not been mapped thoroughly. This might be achieved by the historical digital data (old maps, aerial imagery, written text) that serve as basis for recreation of the historical terrain and ditch network, which supplied water for almost twenty lakes and ponds used by monks.

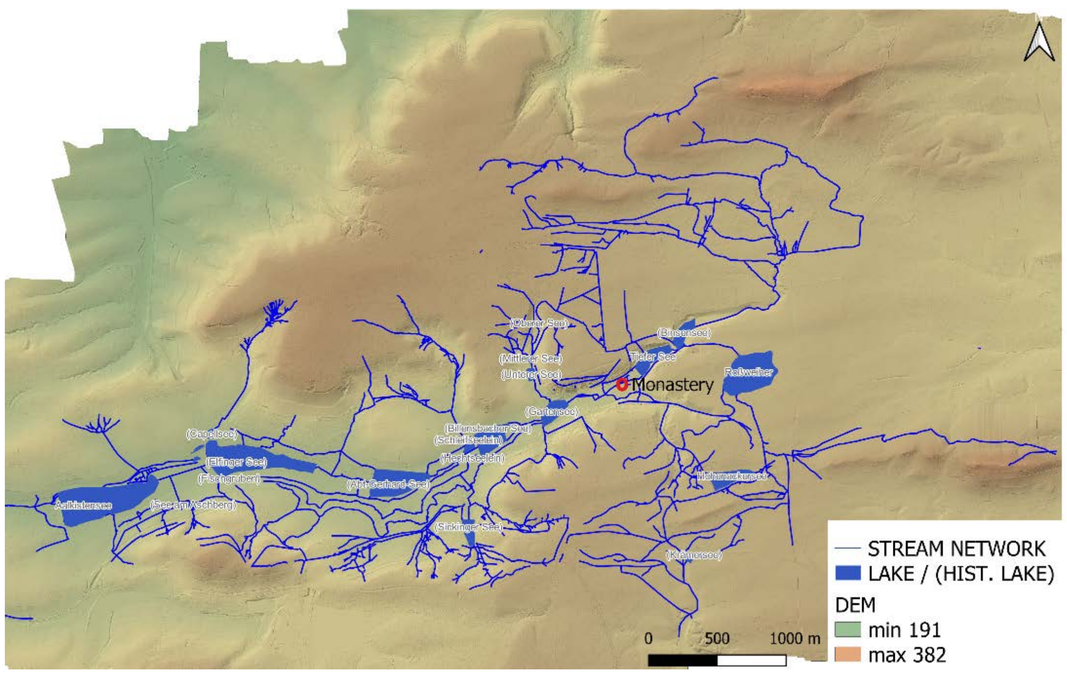


*Figure 1. DEM representation with historical lakes and ditch network.*

In the course of this study, the multispectral imagery (both aerial and UAV - see Figure 3) are employed to discover subsurface features that present themselves as ditches by using the hypothesis of the positive crop mark used in archaeology remote sensing, as presented in Figure 2.

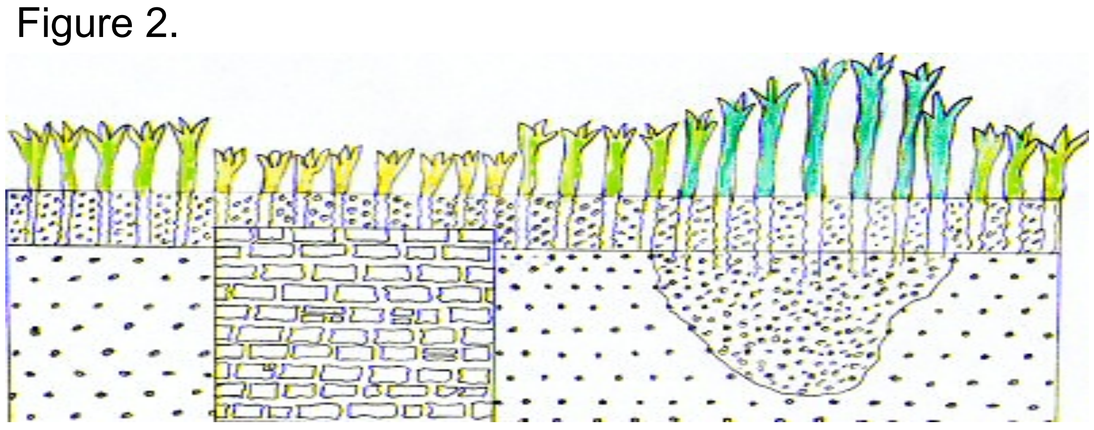

*Figure 2. Negative (left) and positive (right) cropmark example.*

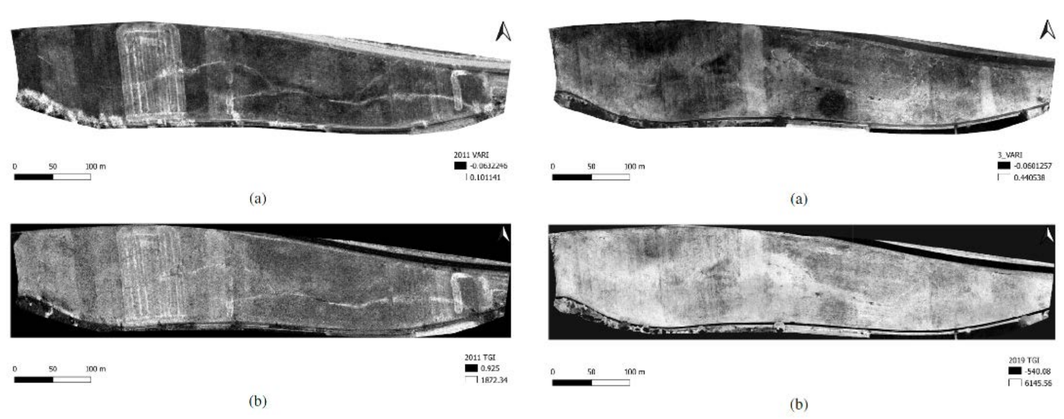


*Figure 3. Aerial (left) and UAV (right) multispectral image analysis in ditch mapping.*

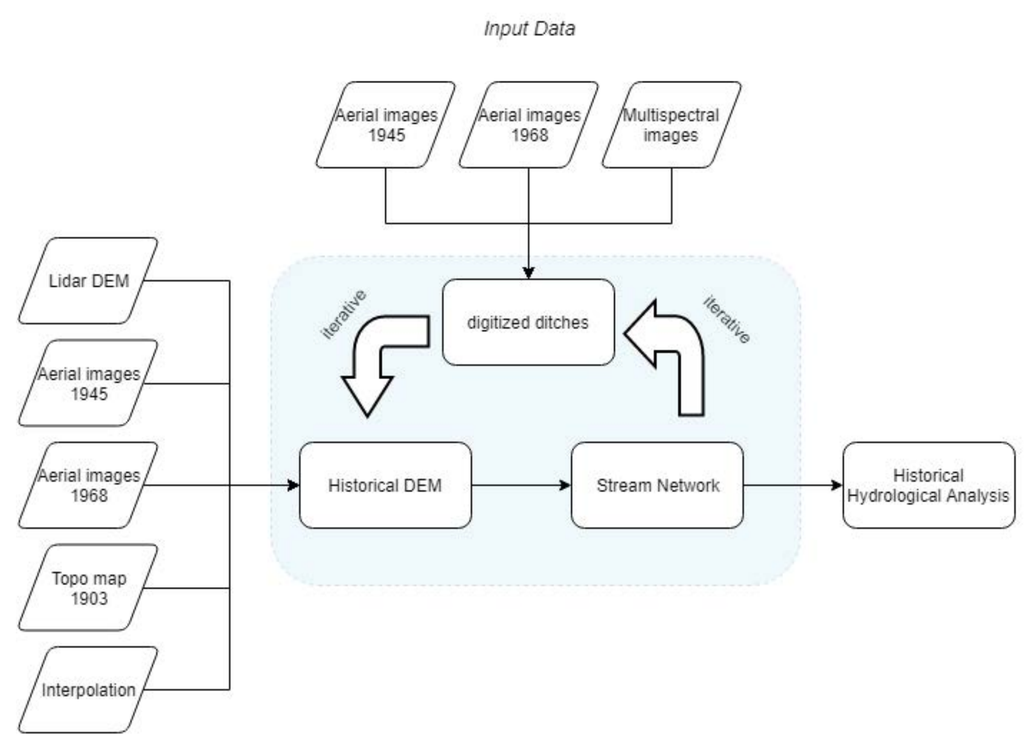


*Figure 4. Overview of the research methodology*

Thus, the first step was to improve existing historical DEM based on various historical data as well as improved ditch network. This process was iterative (see Figure 4) and was repeated until desired watersheds were derived – see Figure 5. The yearly runoff estimation per lake and watershed was derived, assessing how much water each water body harvested throughout the year.

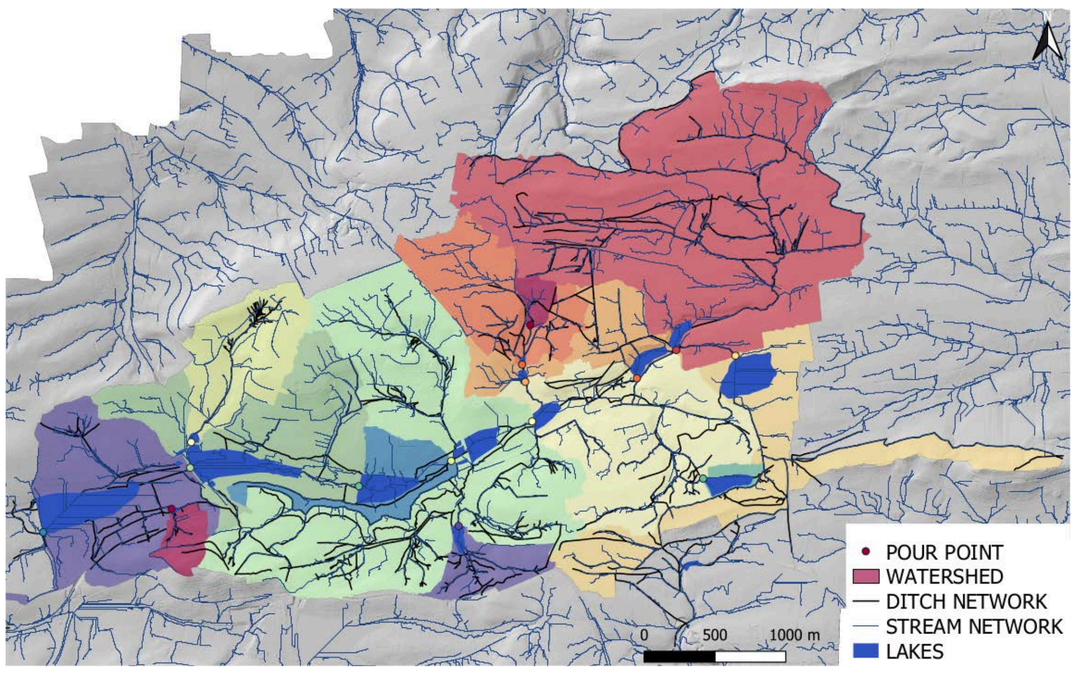


*Figure 5. Derived historical watersheds.*

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