UAV thermal images to support the study of the expansion and contraction dynamics of river networks: a preliminary methodological approach

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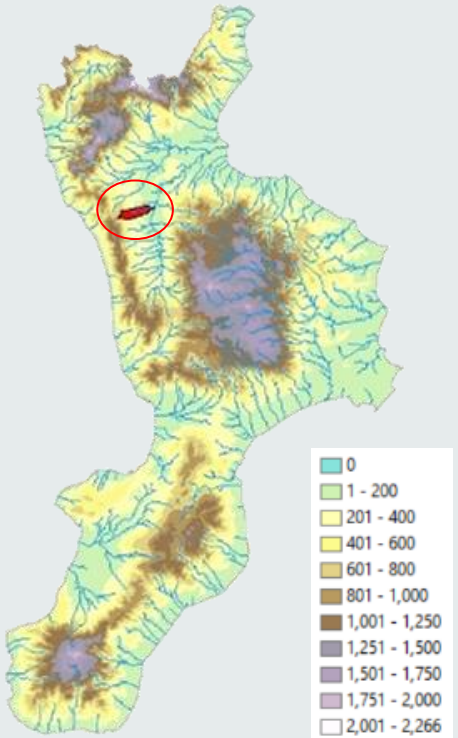
Study Concept

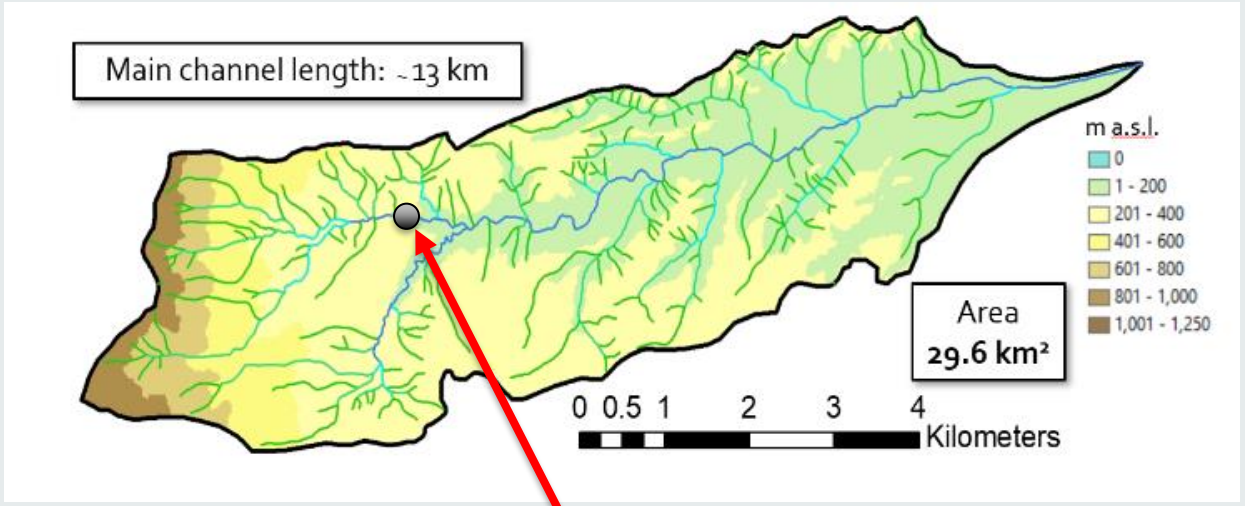
River networks are dynamic entities, periodically subject to expansion and contraction processes due to natural hydrological and climatic fluctuations. The ERC project "DyNET: Dynamical River Networks" aims at providing a systematic and quantitative description of such processes. The experimental activities are focused on the mapping at the basin scale of the active (i.e., characterized by flowing water) portion of the river network with the aid of drones, satellite images and field surveys, for the collection of data useful to the modelling of evolutionary processes and the development of theories to be extended on a regional scale. The use of UAVs (Unmanned Air Vehicles) specifically concerns the observation of the space-time evolution of processes, allowing to monitor wide areas and identify the presence/absence of flowing water in the river network with the help of infrared (IR) thermal imaging cameras.

Experimental method discussed

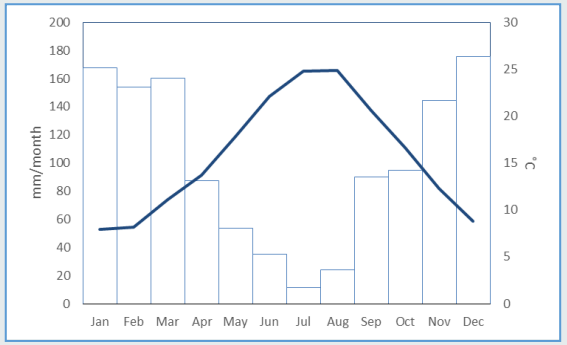
The contribution discusses the effectiveness of UAVs for river networks dynamics monitoring in the Turbolo creek network (Calabria, southern Italy). Specifically, an experimental method is described that identifies and extrapolates from thermal images the pixels representing the active river network. The method is defined based on multiple acquisitions of thermal IR images on a channelized site in different daytimes and flight altitudes. During the experiment, made on 22 October 2019, air temperature data were recorded by a weather station near the test area, as well as the water temperature values in a small control area in the river bed, with the ascertained presence of water, monitored by the UAV. The thermal images were analyzed on GIS software, extrapolating the pixels falling within a range of values defined from the control area. The "water pixels" thus obtained allowed, through appropriate post-processing, to reconstruct the parts of the canal wet. The methodology developed can be used allows defining, in different periods of the year and weather conditions, the expansion/contraction dynamics of river networks.

Study site: Turbolo Creek catchment - Calabria, Italy





Survey point



Average rainfall 1200 mm
Average temperature 16,5 ° C

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Flight instruments and parameters

22 October 2019

Flight	Time	N. photo	Height (m)	GSD (cm)
1	09:15	3	22 – 56 – 78	2 – 5 – 7
2	12:45			
3	16:00			

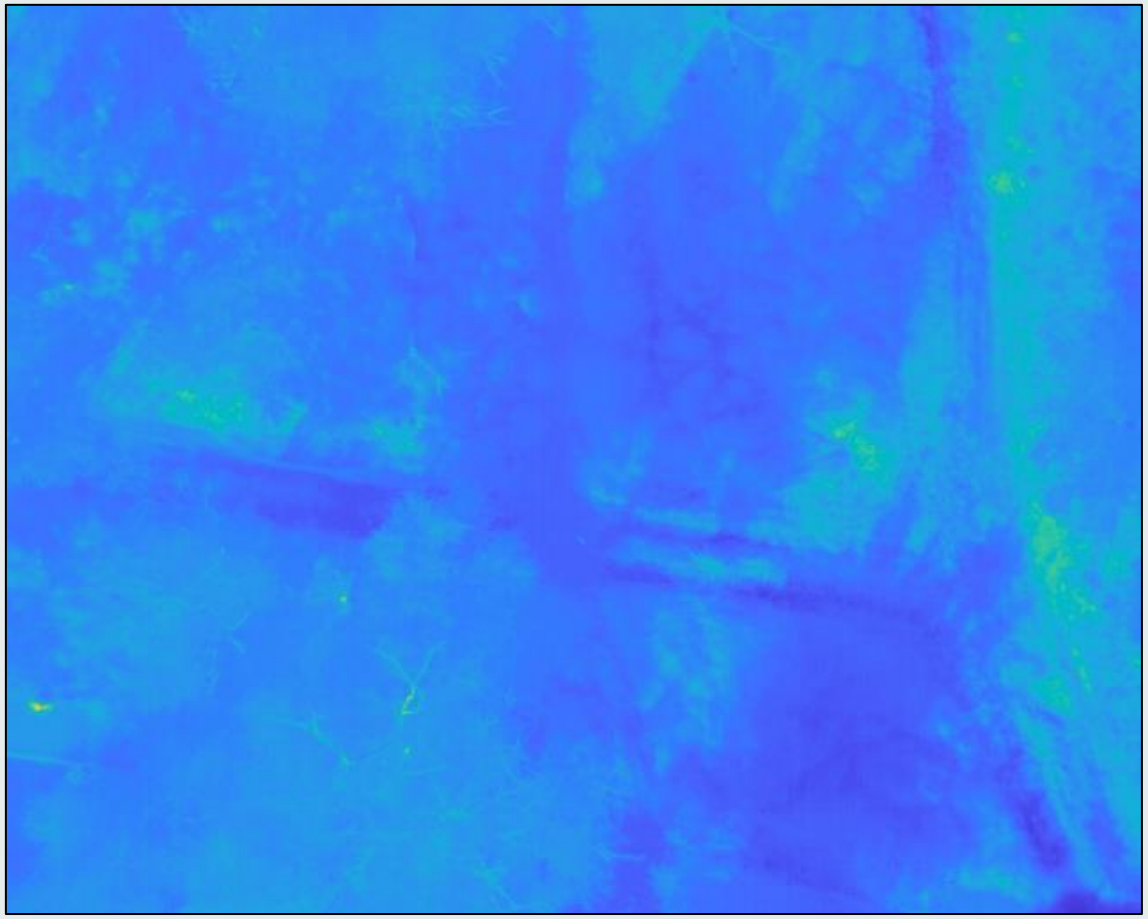
Flight parameters; GSD = ground sample distance

Flight	Time	T ° C water	T ° C air	ΔT ° C water/air
1	09:15	14.1	15.8	1.7
2	12:45	15.9	24.8	8.9
3	16:00	16.5	25.8	9.3

Air temperature values were recorded by a weather station near the test area, as well as the water temperature values in a small control area in the river bed

Thermal camera Zenmuse XT2 Radiometric	
Thermal sensor	640x512 pixel size 17 µm
Lens	19 mm
Spectral band	7,5 - 13,5 µm
Sensitivity	<50 mk @ f/1.0
Visual sensor	1/1.7" CMOS 12 MP
Lens	8 mm

RGB image *vs.* IR image



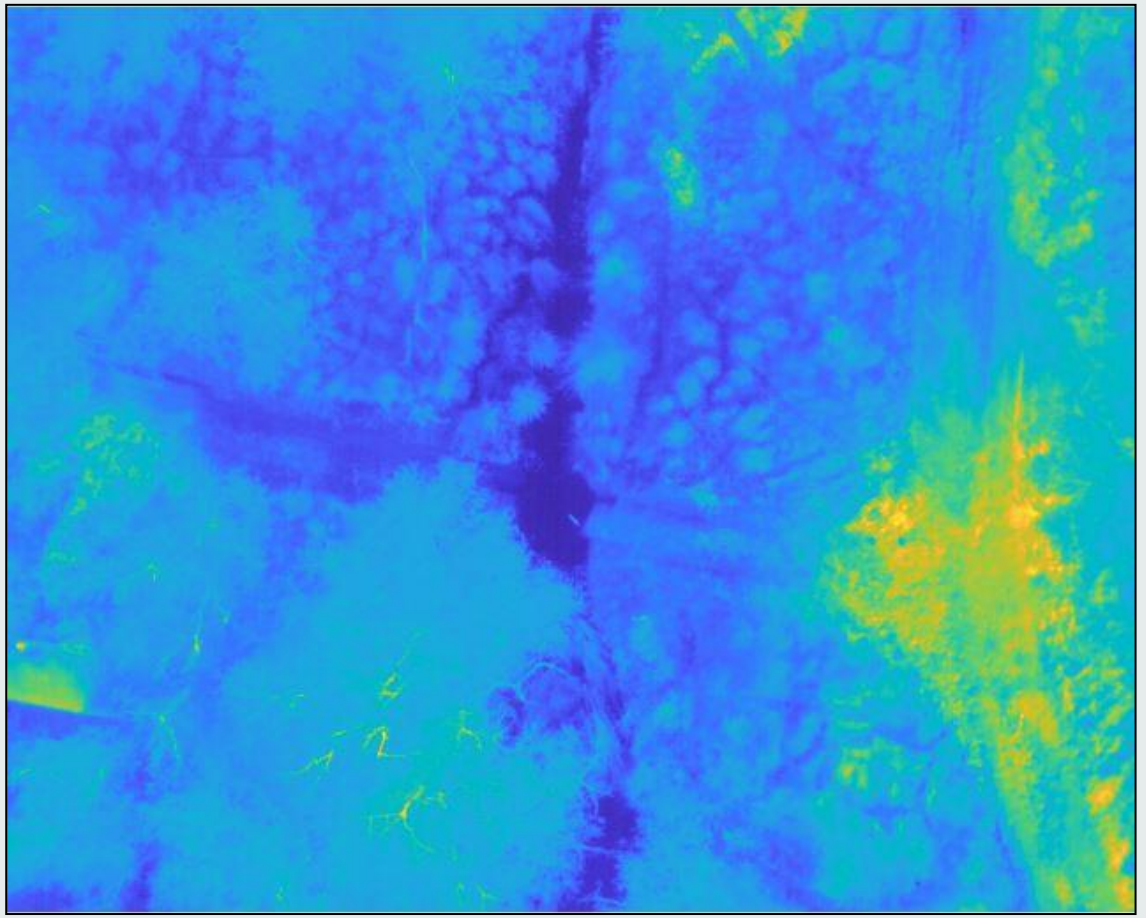
22/10/2019 – 09:15

T water = 14.1 °C, T air = 15.8 °C

ΔT = 1.7 °C

With a low ΔT it is difficult to discriminate the presence of water in the IR image

RGB image *vs.* IR image



22/10/2019 – 16:00

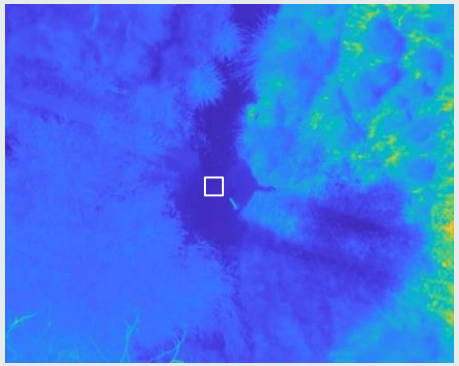
T°acqua = 16.5 °C, T°atmosferica = 25.8 °C

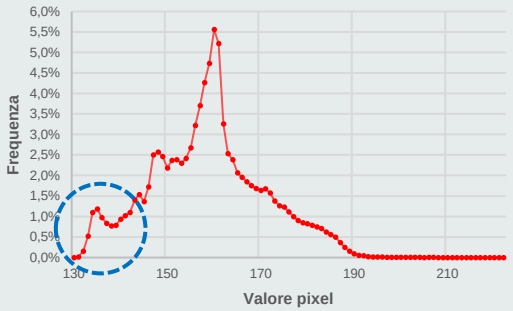
ΔT = 9.3 °C

With a high ΔT it is easier to discriminate the presence of water in the IR image

22/10/2019 12:45, ΔT °C water/air = 8.9°C

Image IR23, H=22m, GSD=2cm, (control matrix 25x25 pixel – min/max: 132-138)





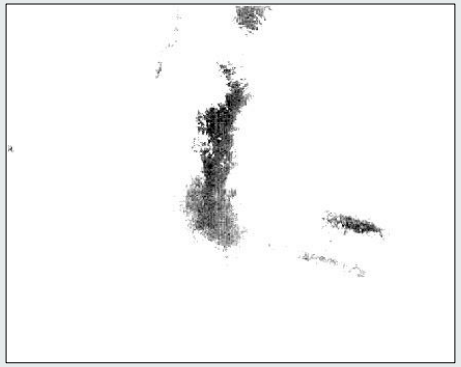
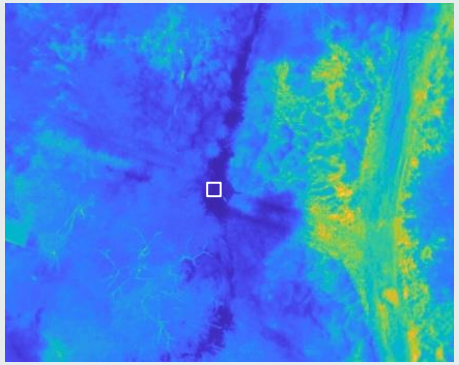
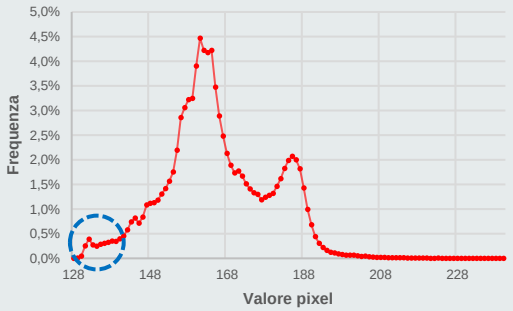


Image IR25, H=56m, GSD=5cm, (control matrix 10x10 pixel – min/max: 130-134)





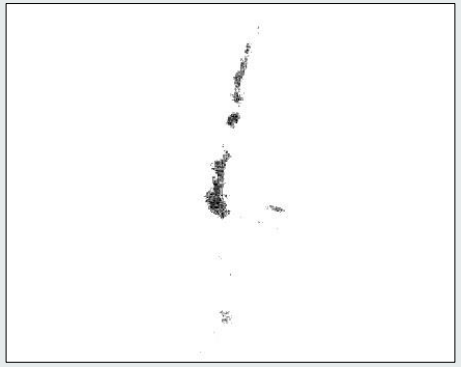
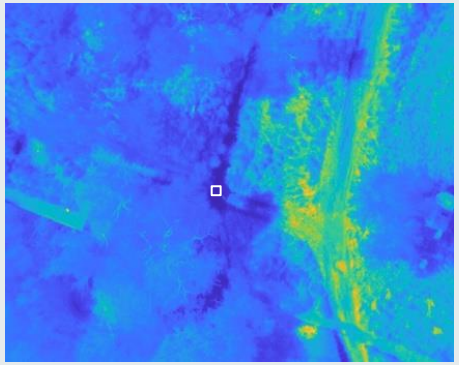
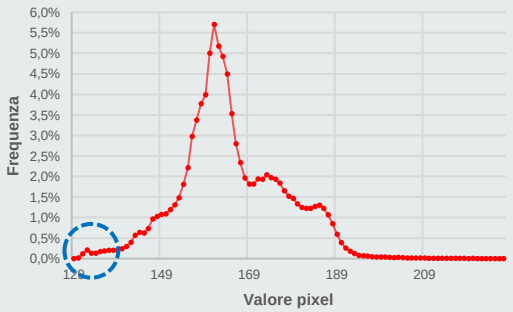
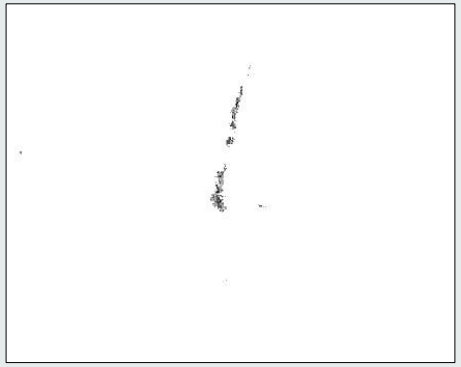


Image IR27, H=78m, GSD=7cm, (control matrix 7x7 pixel – min/max: 130-133)



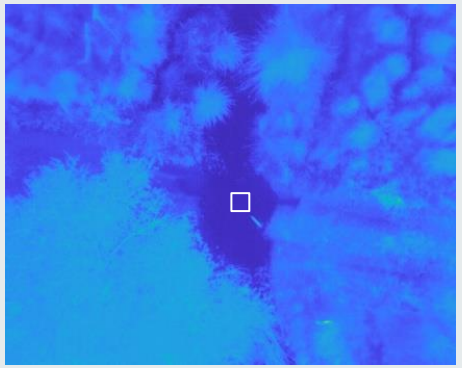


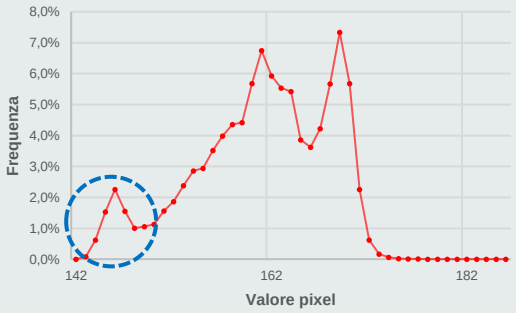


In this case, once the control matrix has been identified, the water pixels can be extrapolated, due to the presence of significant ΔT between water and air

22/10/2019 16:00, ΔT °C water/air = 9.3°C

Image IR35, H=22m, GSD=2cm, (control matrix 25x25 pixel – min/max: 142-148)





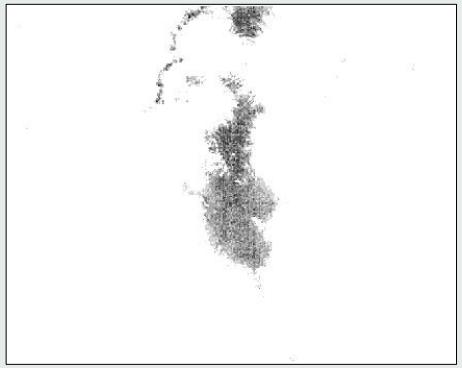
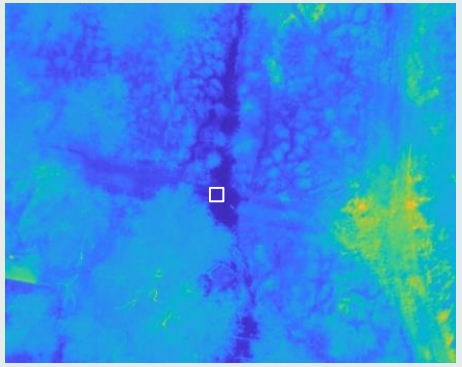
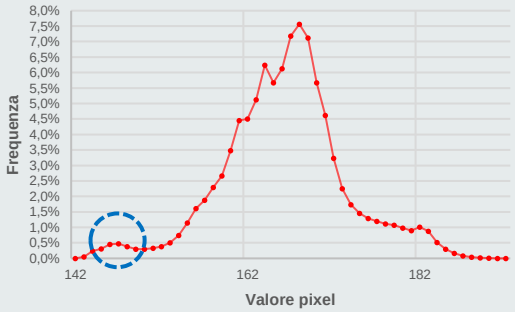


Image IR37, H=56m, GSD=5cm, (control matrix 10x10 pixel – min/max: 143-146)





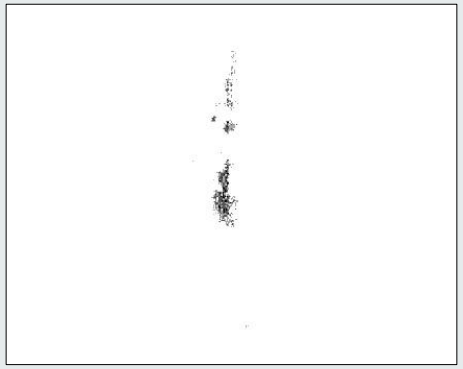
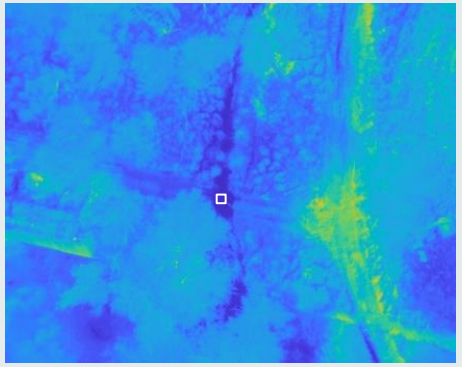
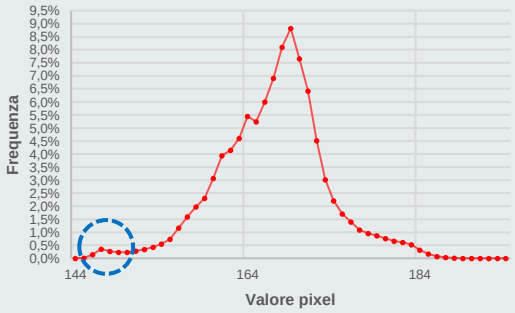
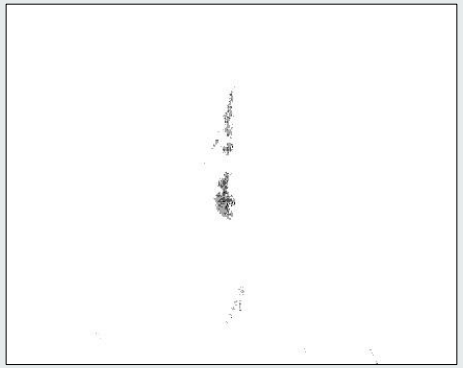


Image IR39, H=78m, GSD=7cm, (control matrix 7x7 pixel – min/max: 145-148)



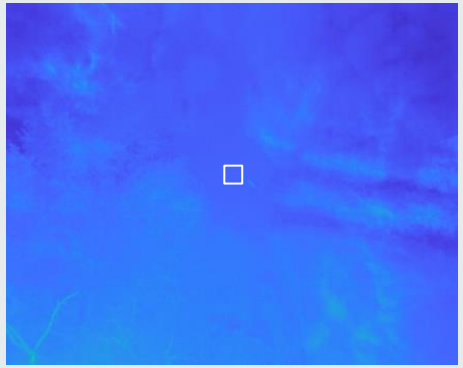




Also in this case, once the control matrix has been identified, the water pixels can be extrapolated, due to the presence of significant ΔT between water and air

22/10/2019 09:15, ΔT °C water/air=1.7°C

Image IR11, H=22m, GSD=2cm, (control matrix 25x25 pixel – min/max: 109-113)



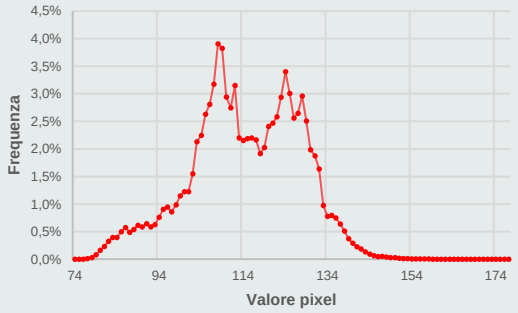
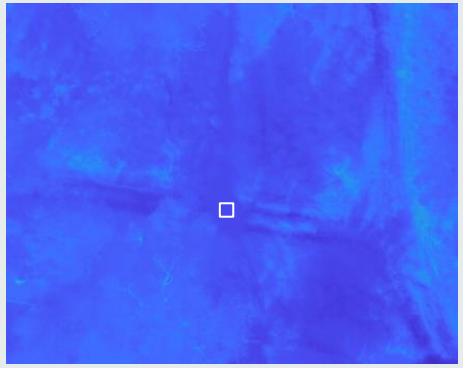
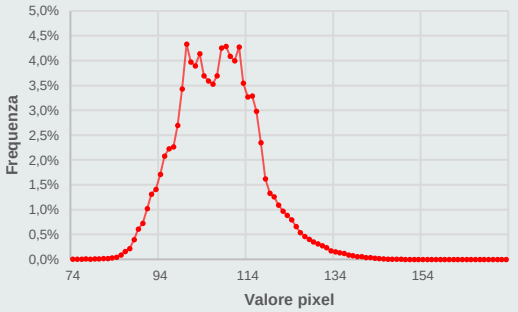


Image IR13, H=56m, GSD=5cm, (control matrix 10x10 pixel – min/max: 92-96)





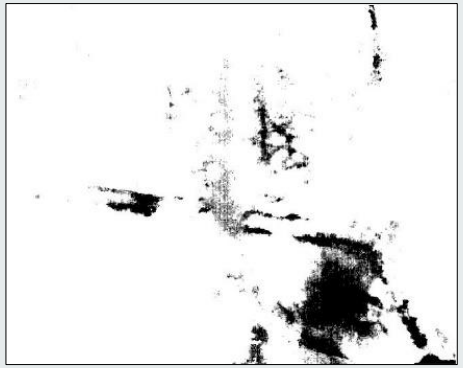
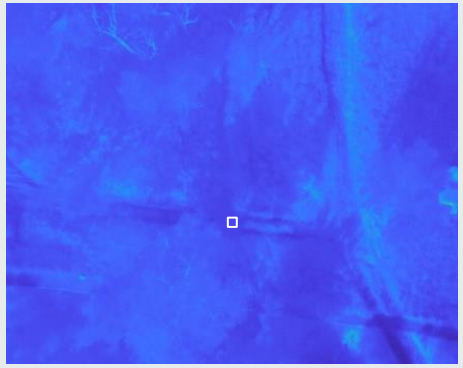
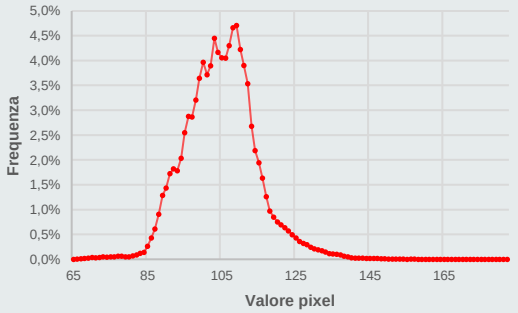
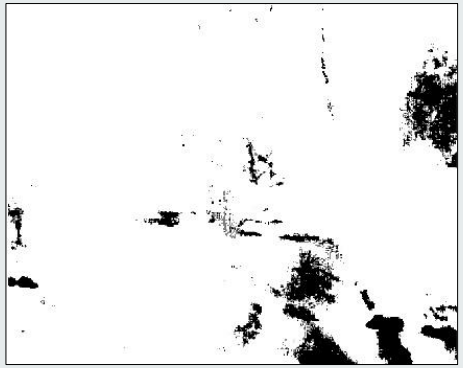


Image IR15, H=78m, GSD=7cm, (control matrix 7x7 pixel – min/max: 90-92)







If ΔT is not high enough, it is not possible to correctly extrapolate the water pixels

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