



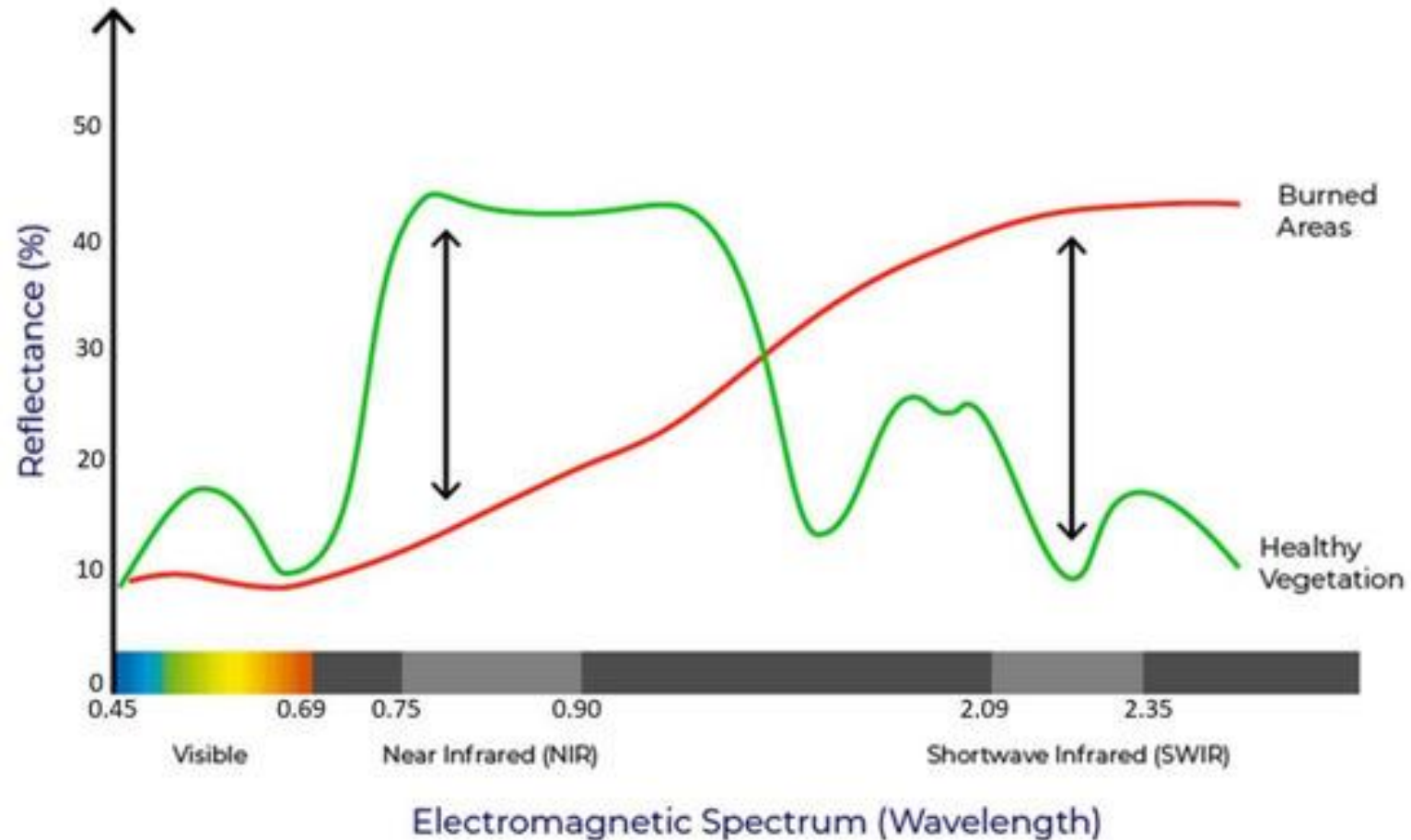
Uso di reti generative per la fusione di dati SAR e ottici nella mappatura di incendi boschivi

Donato Amitrano
Centro Italiano Ricerche Aerospaziali

Workshop
“Tecnologie satellitari e analisi multi-rischio:
l’esperienza dei progetti I4DP_SCIENCE e prospettive future”
28 Maggio 2025



Agenzia Spaziale Italiana

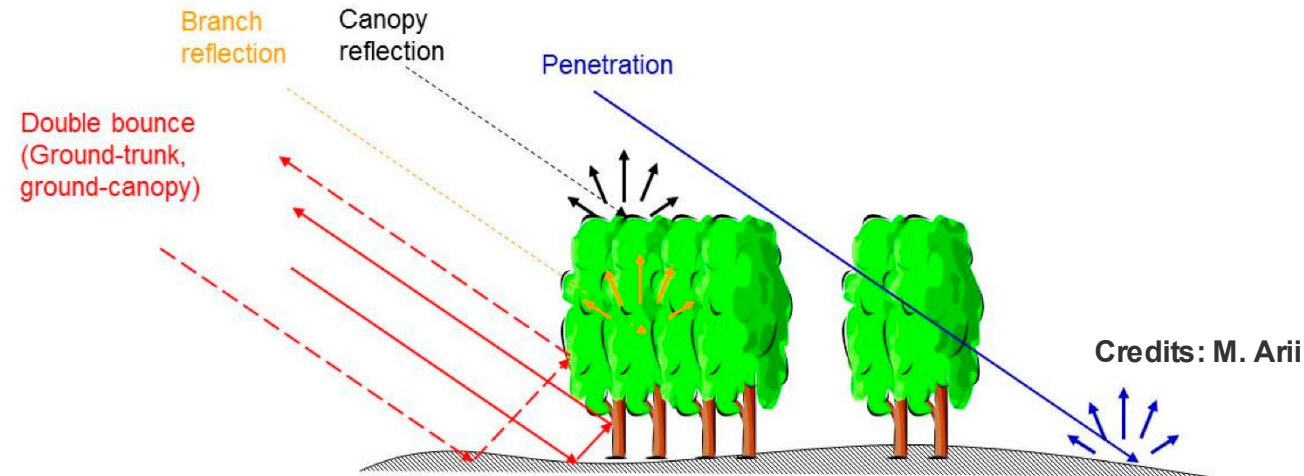


$$NBR = \frac{NIR - SWIR}{NIR + SWIR}$$

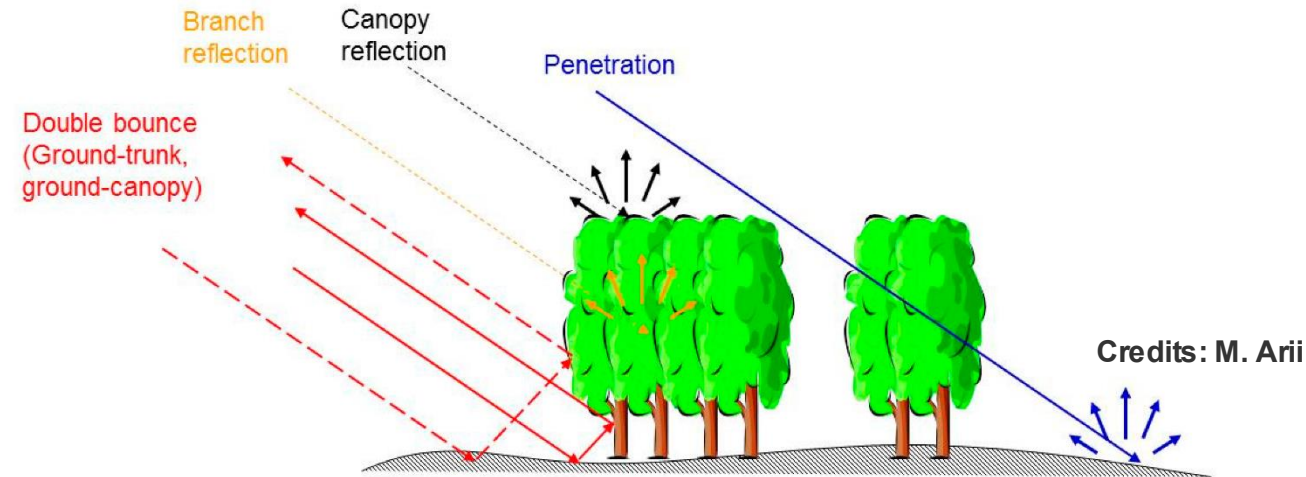
$$\Delta NBR = NBR_{pre} - NBR_{post}$$

dNBR value	Class
$dNBR \leq 0.099$	No fire
$0.099 < dNBR \leq 0.269$	Low severity
$0.269 < dNBR \leq 0.439$	Moderate-low severity
$0.439 < dNBR \leq 0.659$	Moderate-high severity
$dNBR > 0.659$	High severity

- Ampiezza
 - Riduzione backscattering dovuta alla rimozione delle chiome
 - Aumento backscattering dovuto a fenomeni di riflessione multipla tra i rami
 - Aumento backscattering legato alla costante dielettrica

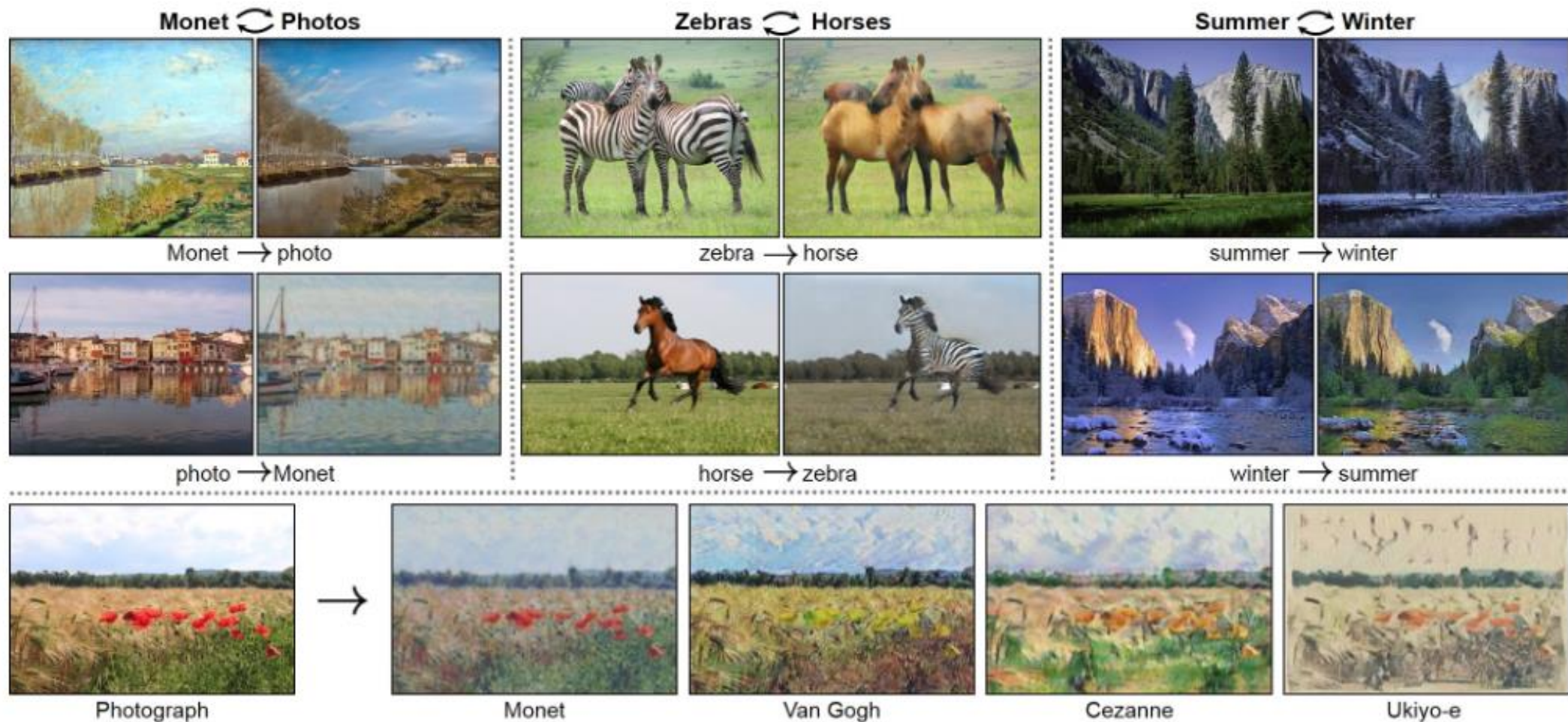


- Ampiezza
 - Riduzione backscattering dovuta alla rimozione delle chiome
 - Aumento backscattering dovuto a fenomeni di riflessione multipla tra i rami
 - Aumento backscattering legato alla costante dielettrica
- Fase
 - Riduzione della coerenza interferometrica dovuta al cambiamento della scena

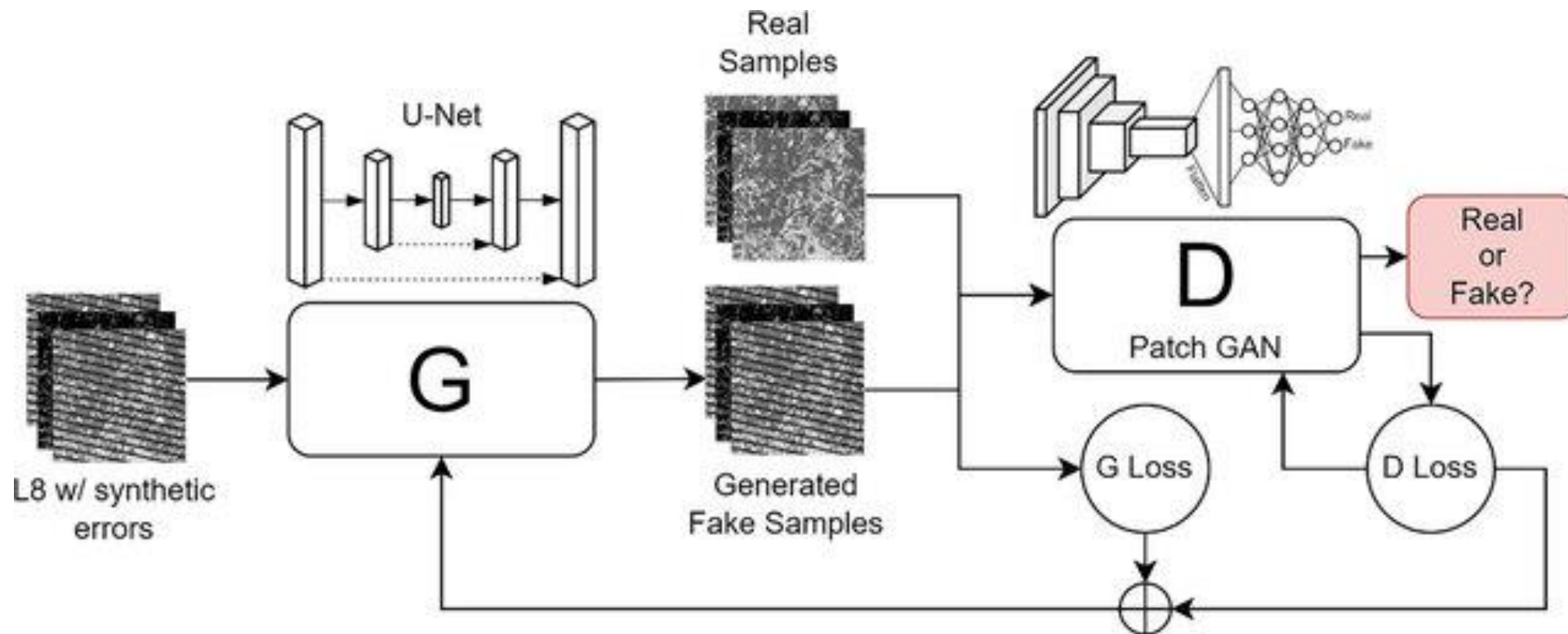


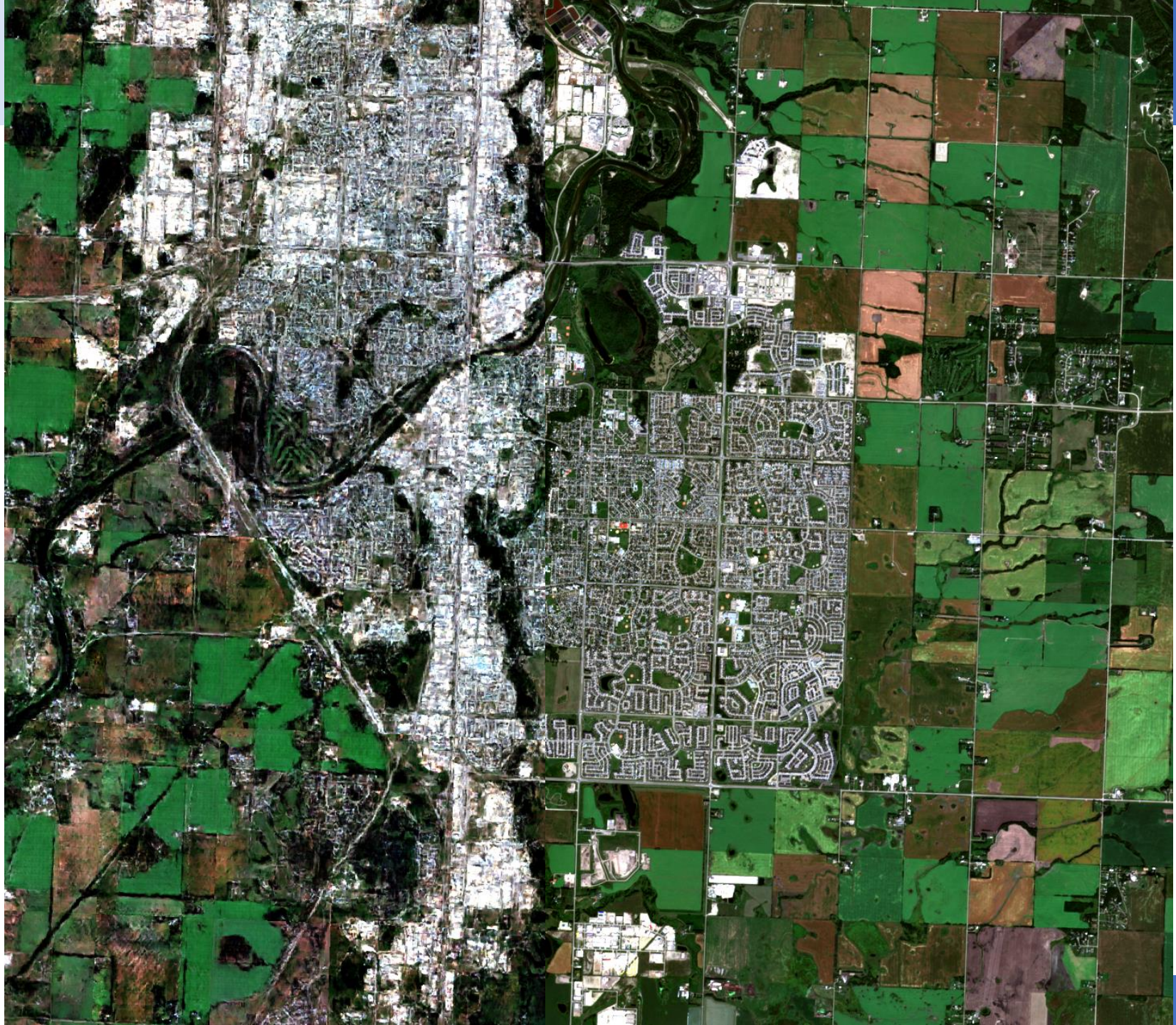
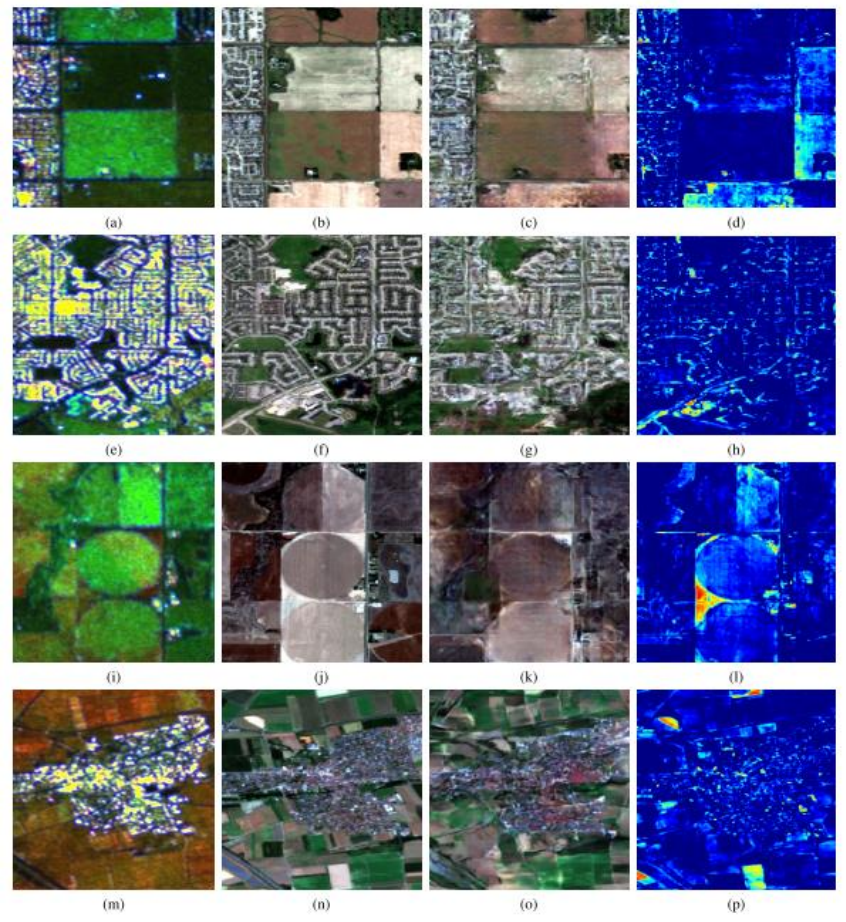
Dataset	σ_{vv}		σ_{vh}		γ_{vv}		γ_{vh}	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
EMSR686	-10.0	-10.3	-15.9	-16.9	0.27	0.18	0.20	0.11
EMSR687	-8.53	-7.57	-14.4	-13.9	0.75	0.41	0.67	0.34
EMSR180	-9.40	-8.57	-14.5	-14.3	0.22	0.26	0.38	0.16
EMSR447	-8.90	-8.11	-14.2	-14.0	0.47	0.23	0.39	0.17
EMSR527	-8.85	-9.85	-14.1	-16.1	0.32	0.11	0.26	0.07
EMSR589	-10.1	-10.3	-15.7	-16.4	0.27	0.19	0.20	0.12
EMSR608	-11.0	-11.5	-16.4	-17.4	0.19	0.12	0.16	0.08
EMSR620	-11.5	-10.4	-16.9	-17.4	0.48	0.18	0.43	0.13
EMSR632	-8.71	-7.33	-14.7	-16.3	0.50	0.23	0.38	0.16
EMSR667	-10.0	-8.88	-15.2	-15.2	0.35	0.16	0.28	0.10
EMSR676	-9.08	-8.86	-14.5	-14.9	0.38	0.15	0.32	0.11
EMSR688	-9.26	-9.44	-14.6	-15.9	0.51	0.22	0.41	0.14
EMSR689	-10.0	-9.57	-15.7	-16.1	0.34	0.16	0.26	0.10
EMSR690	-7.19	-6.05	-12.4	-11.5	0.60	0.29	0.54	0.24

Principi delle reti GAN



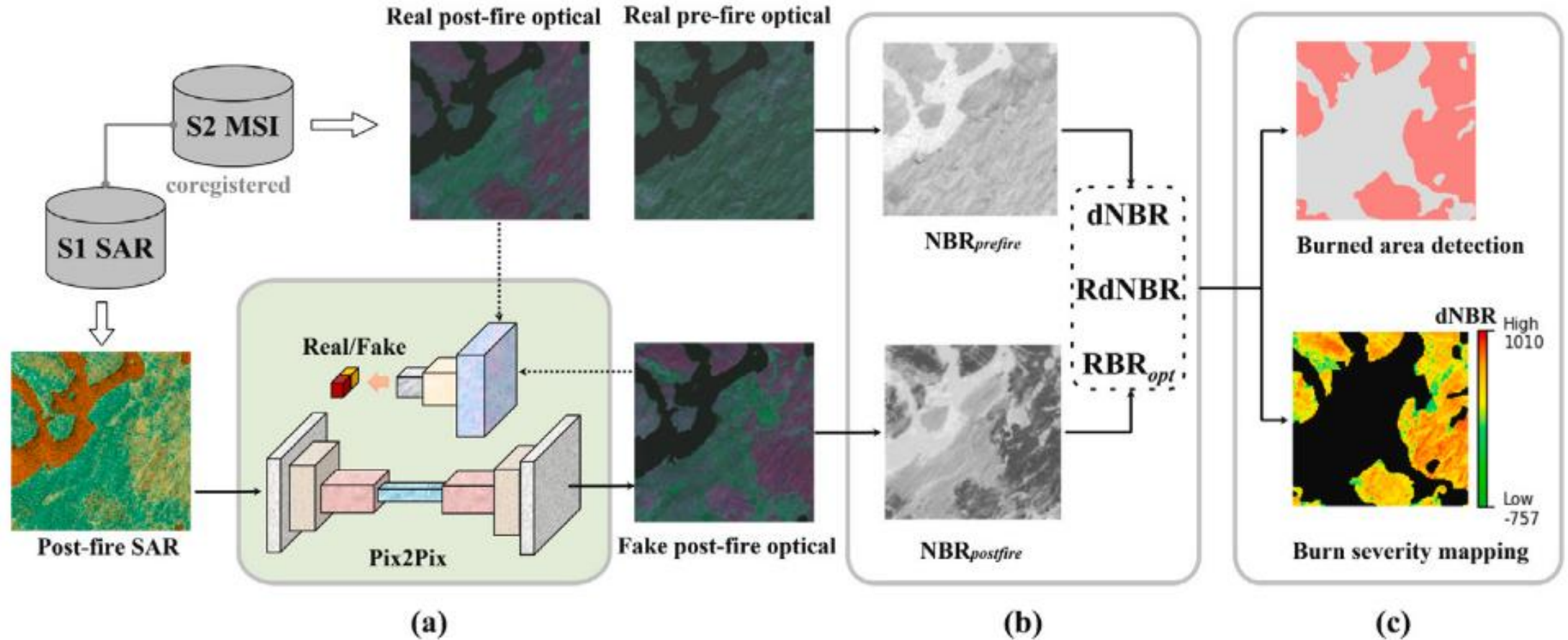
Principi delle reti GAN





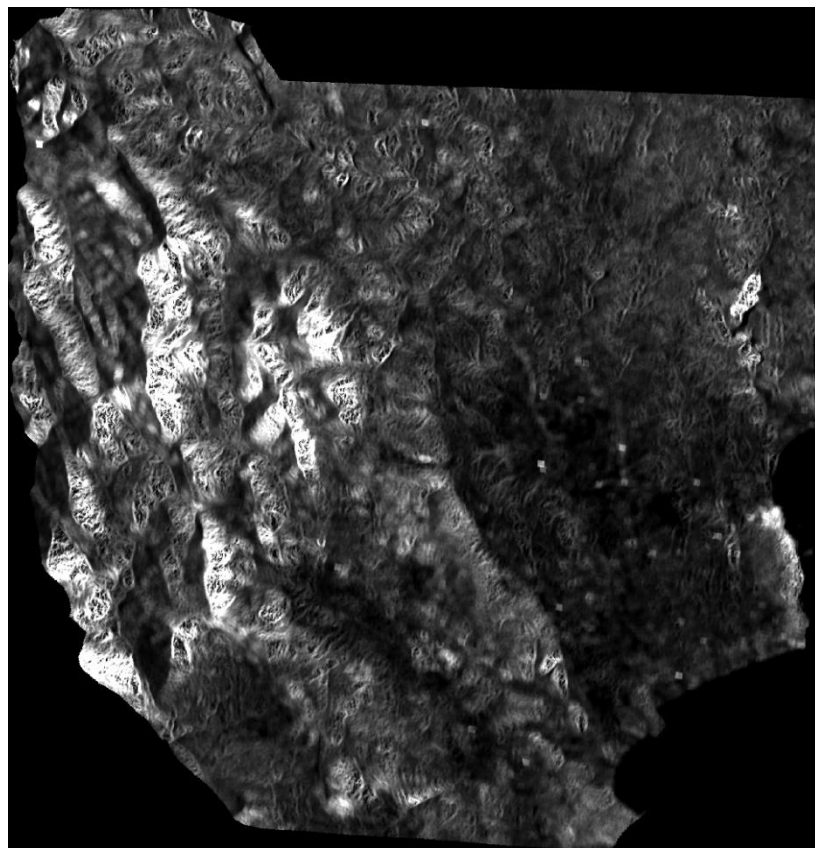
Amitrano, D. (2024). Multitemporal SAR-to-Optical Image Translation Using Pix2Pix with Application to Vegetation Monitoring. *IEEE Access*.

Mappatura incendi boschivi – SAR incoerente

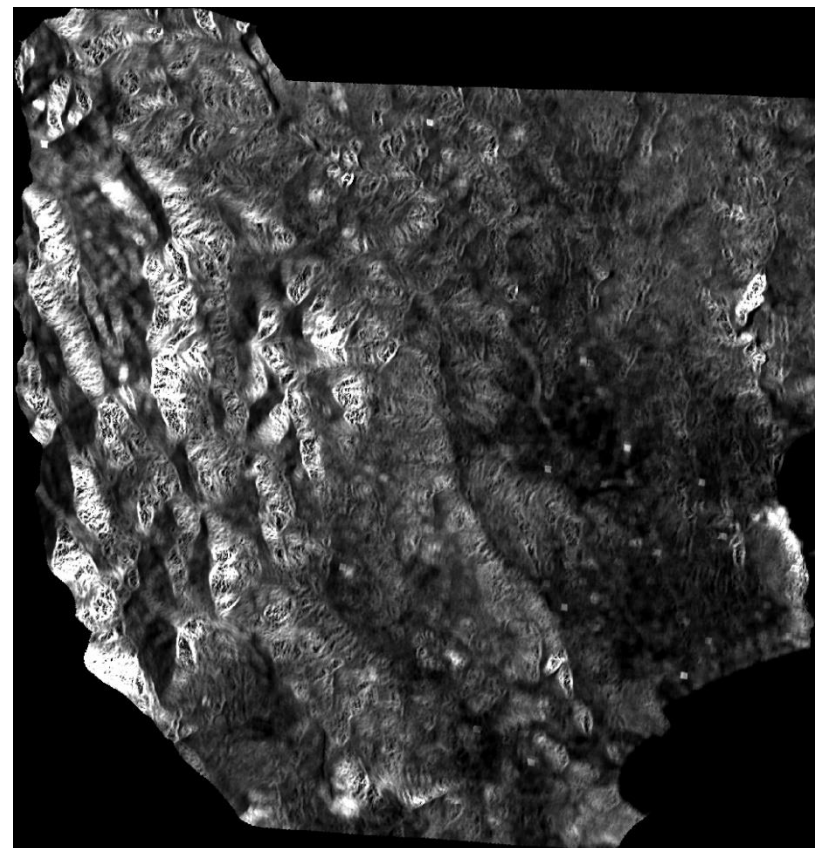


Source: Hu et al. (2023). GAN-based SAR and optical image translation for wildfire impact assessment using multi-source remote sensing data. *Remote Sensing of Environment*, 289

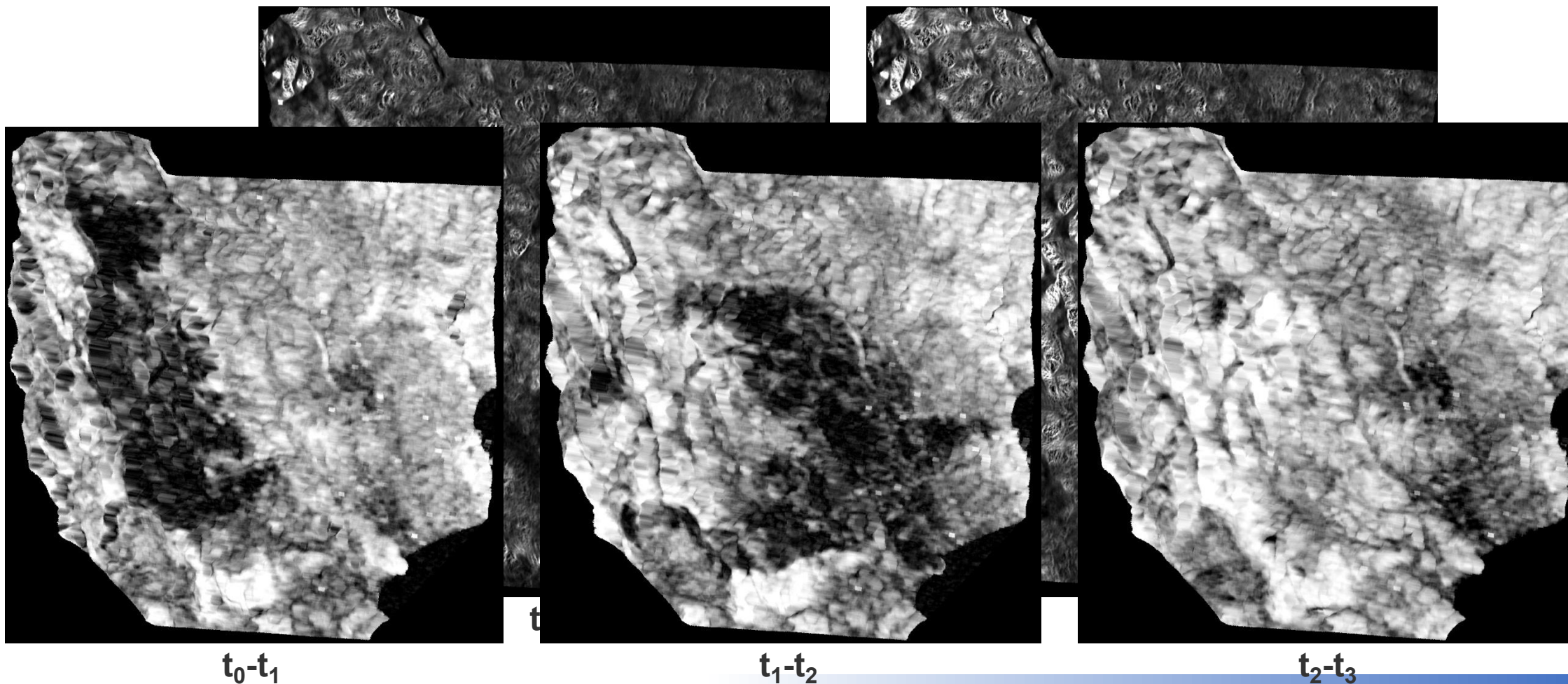
Mappatura incendi boschivi – SAR incoerente



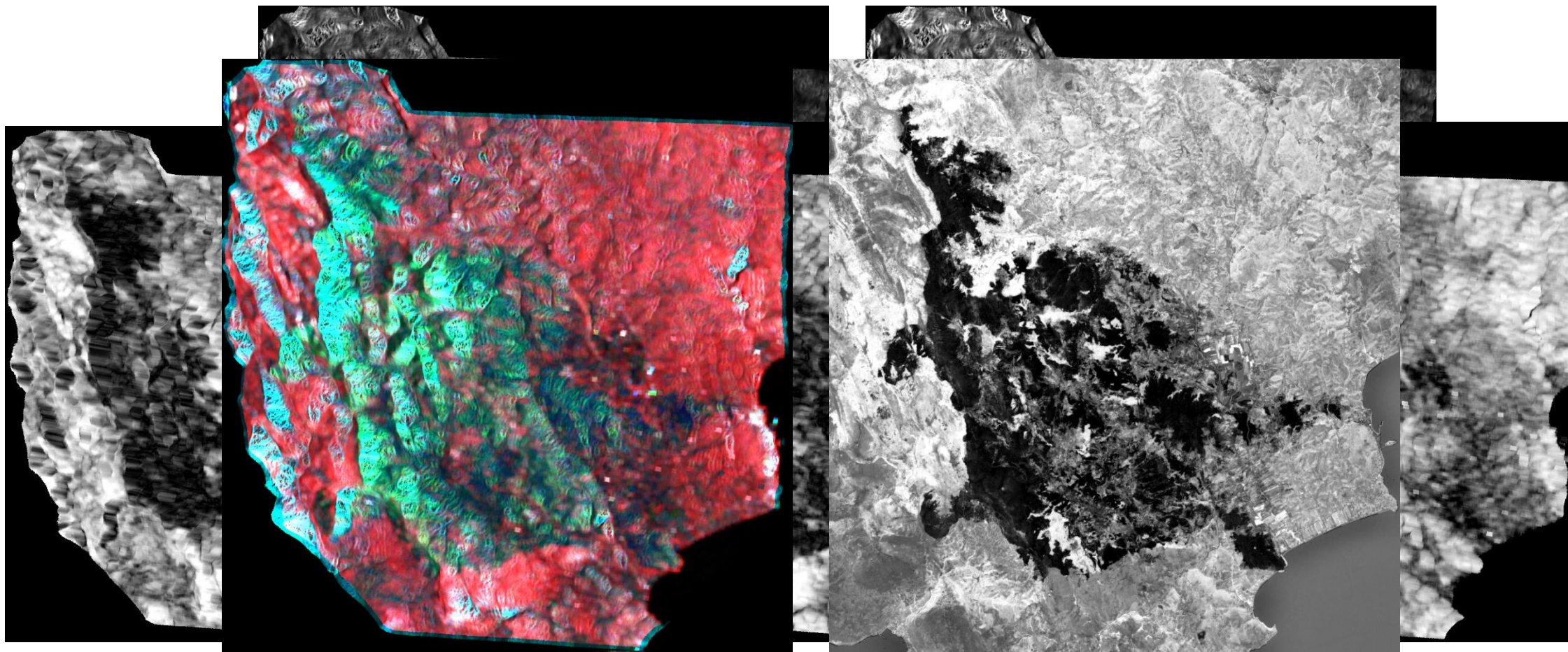
t_0



t_3



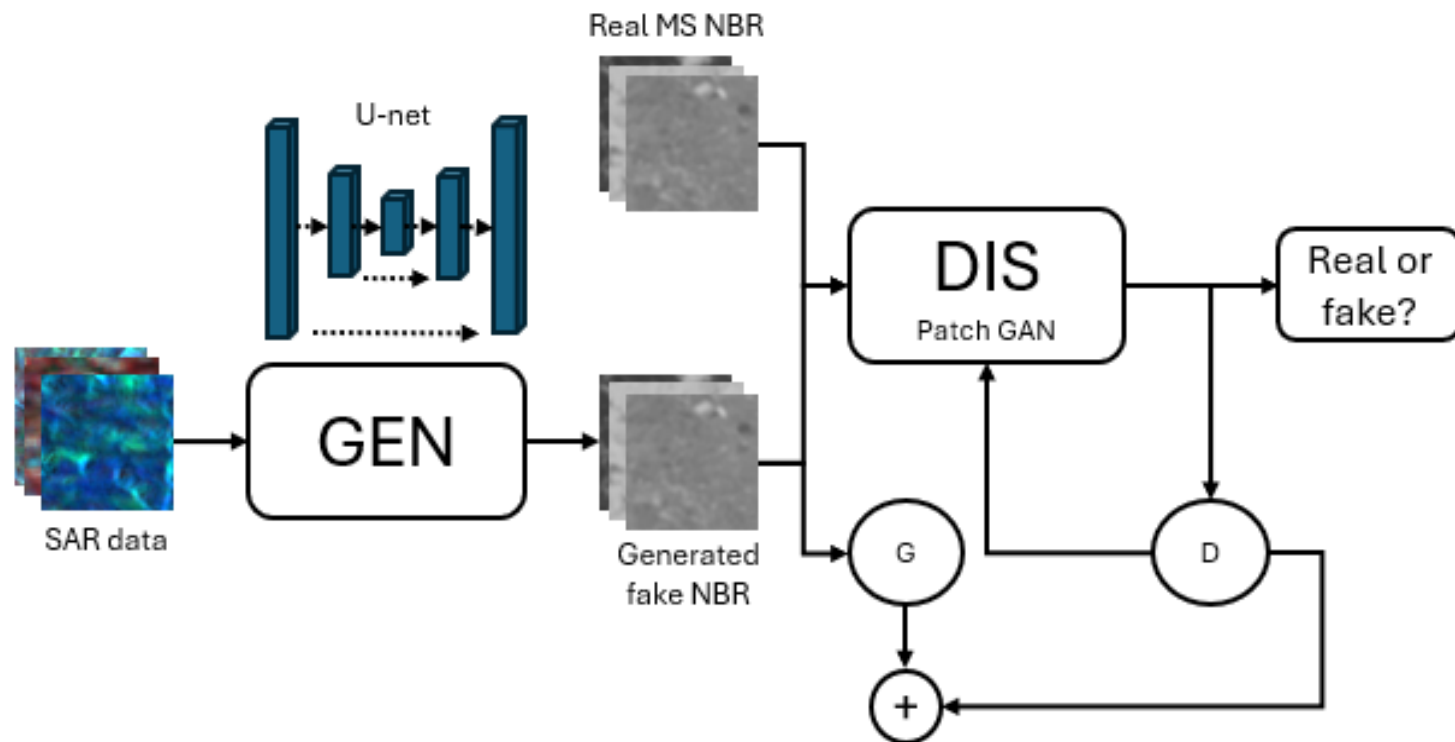
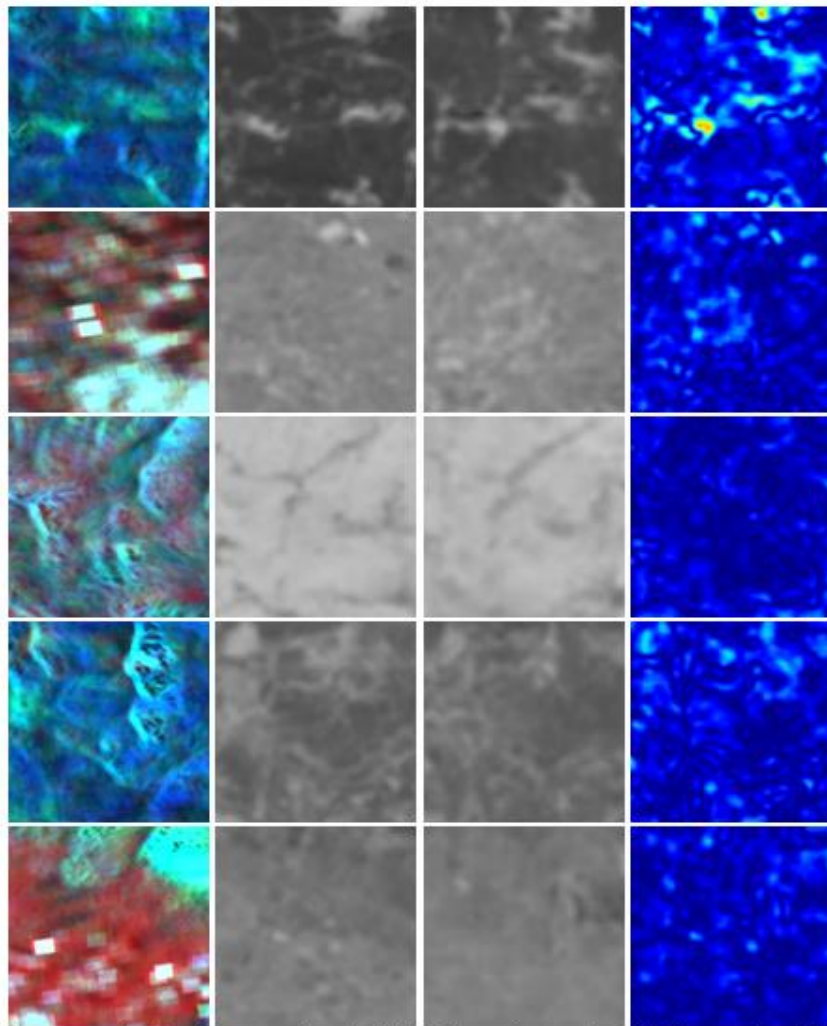
Mappatura incendi boschivi – SAR coerente



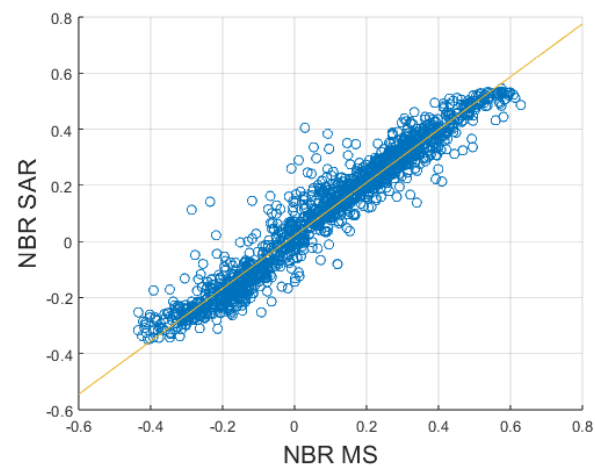
Coherent composite t_0-t_3

NBR t_3

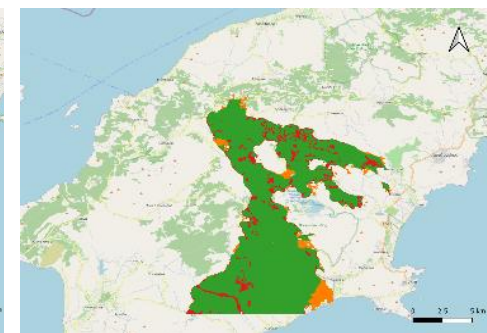
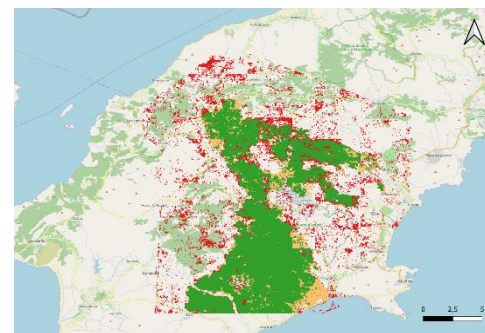
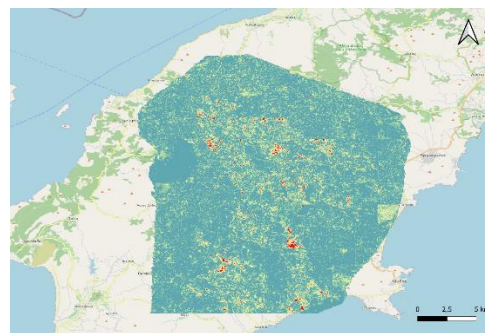
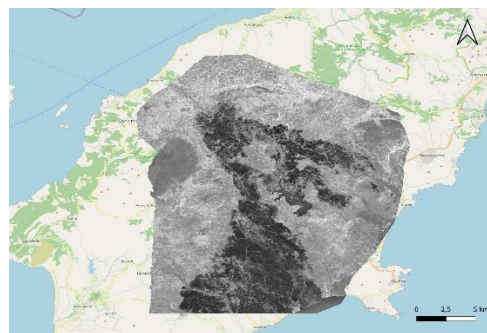
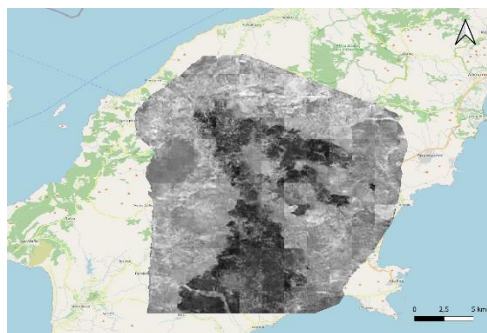
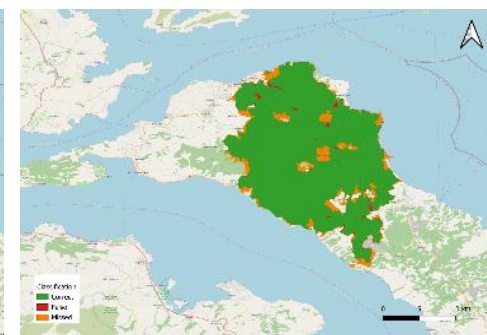
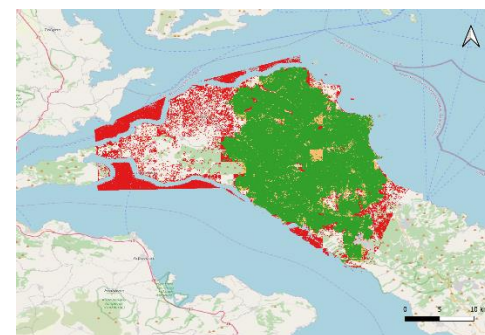
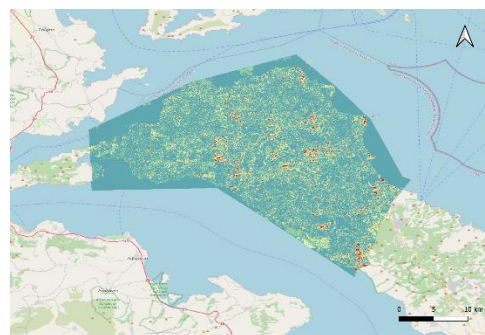
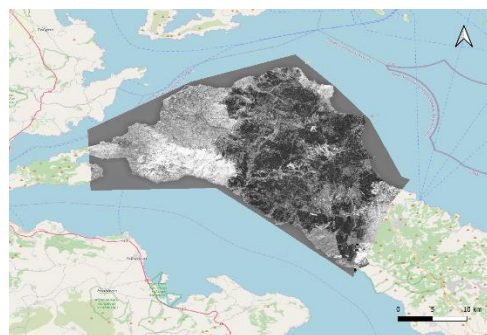
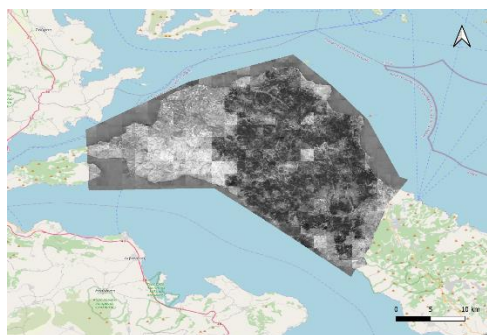
Mappatura incendi boschivi – SAR coerente



Risultati



Method	Classification					
	EBA	FBA	P	R	F ₁	FAR
Coherent VV	131	15.0	0.87	0.95	0.90	4.22
Coherent VH	130	14.2	0.87	0.94	0.91	3.82



Generated NBR

Optical NBR

Difference map

Classification

Refinement

- Il dato SAR coerente costituisce una sorgente valida per il monitoraggio degli incendi boschivi
 - Mappatura dell'evento
 - Tracciamento dei fronti di fiamma (real time)
 - All weather/all time
- Le reti neurali generative sono uno strumento utile per la fusione di dati SAR e MS
 - Mitigazione dei problemi nella classificazione dei dati SAR attraverso paradigmi di change-detection ibrida
- Prospettive future
 - Utilizzo dati IRIDE/CSK
 - Abilitazione tempo reale
 - Small sat/costellazioni dedicate