ANNEX I

Hydraulic model results

This annex pretends to cover the hydraulic modelling by the hydrographs and maps disposed. As it is possible to perceive, the different return periods (20, 100, 200 and 500) are mapped for depth and velocity. This comes from the European regulations exposed in chapter 2.

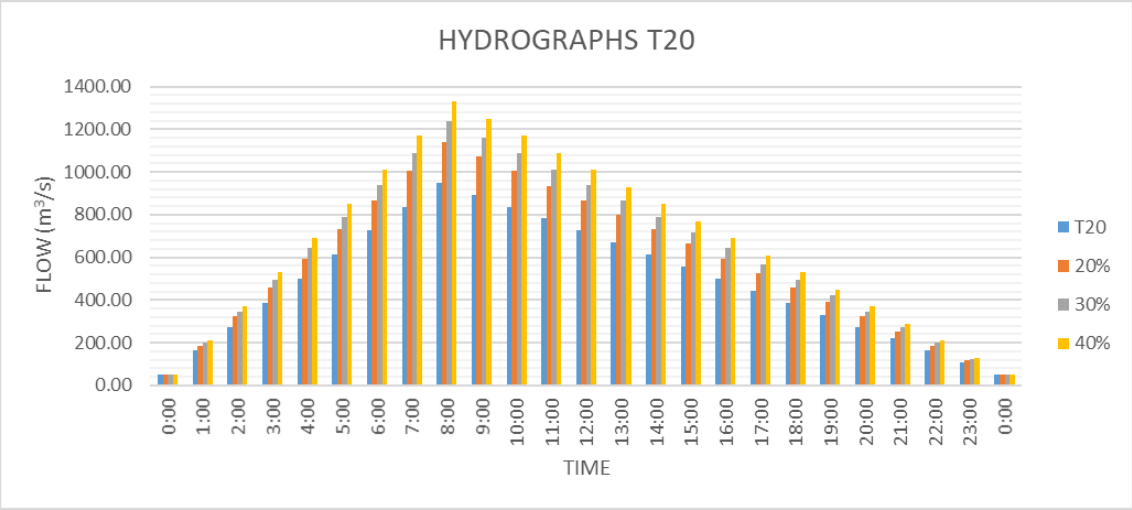

Figure 1: Hydrograph for T20 and CC increasing

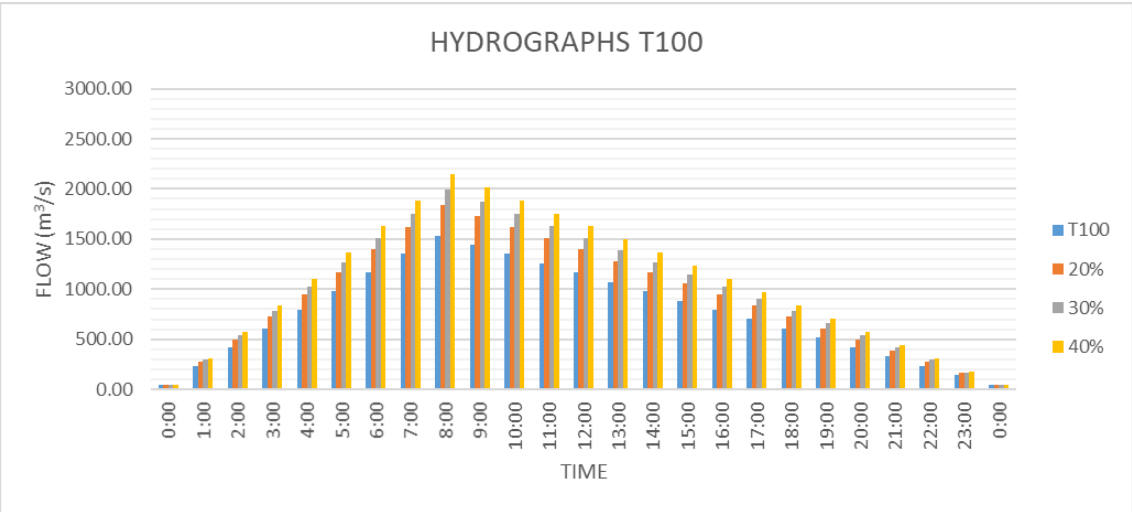

Figure 2: Hydrograph for T100 and CC increasing

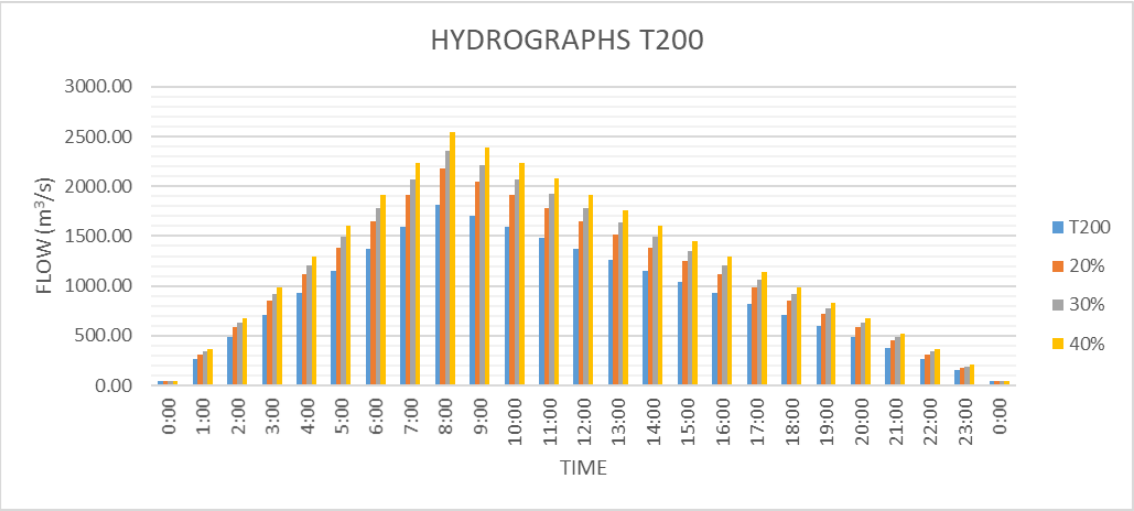

Figure 3: Hydrograph for T500 and CC increasing

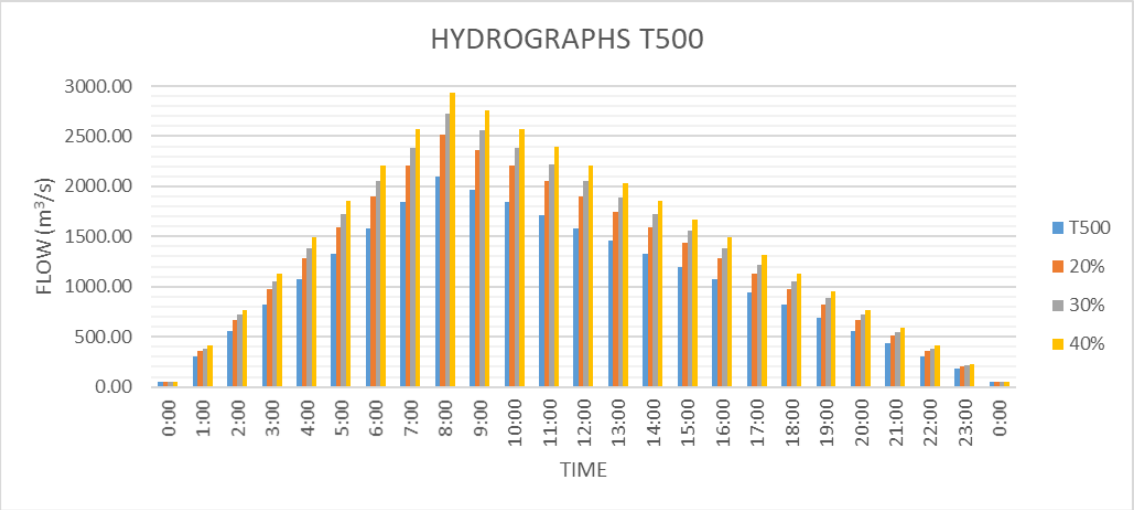

Figure 4: Hydrograph for T500 and CC increasing

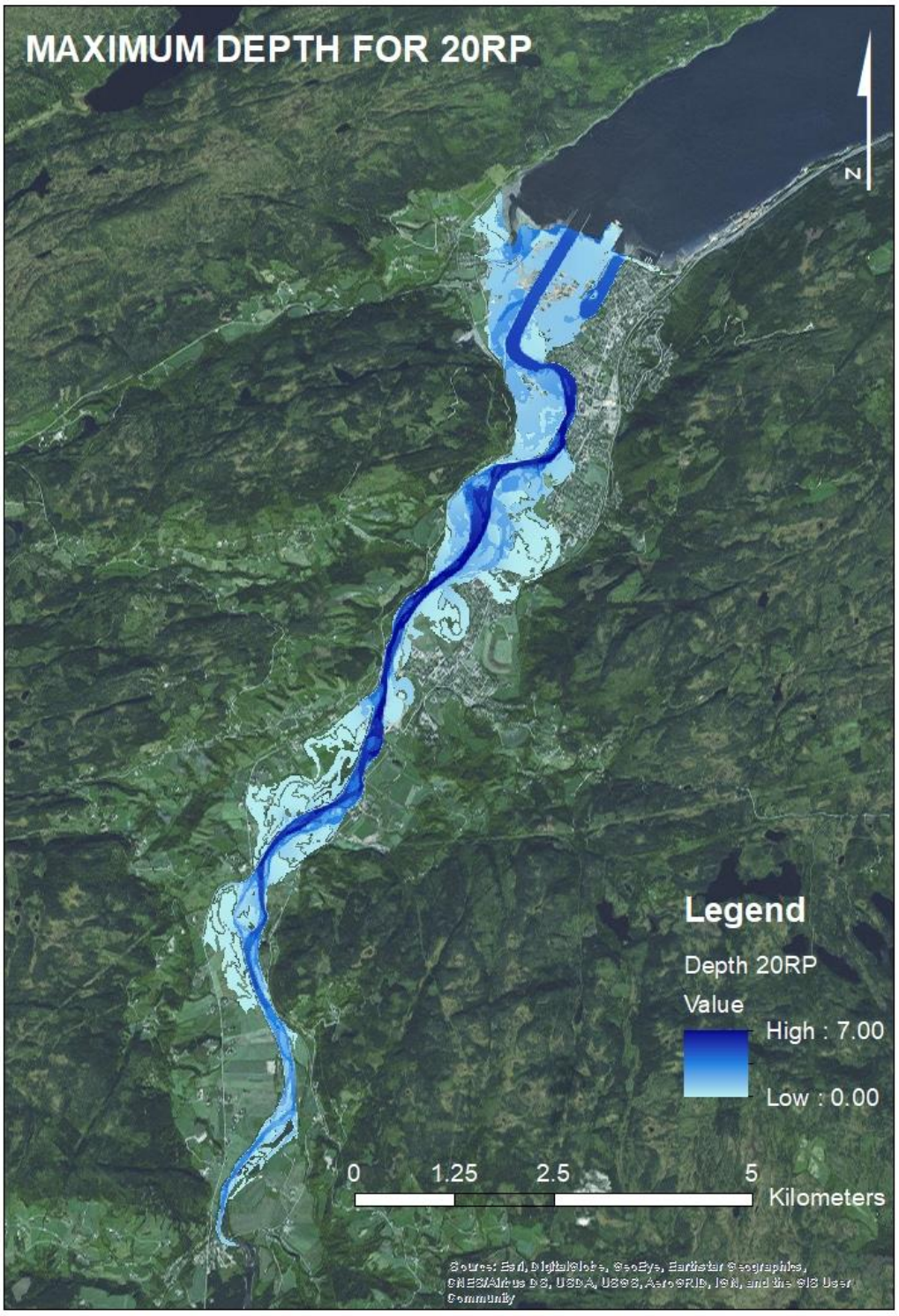

Figure 5: Maximum Depth for 20 years return period

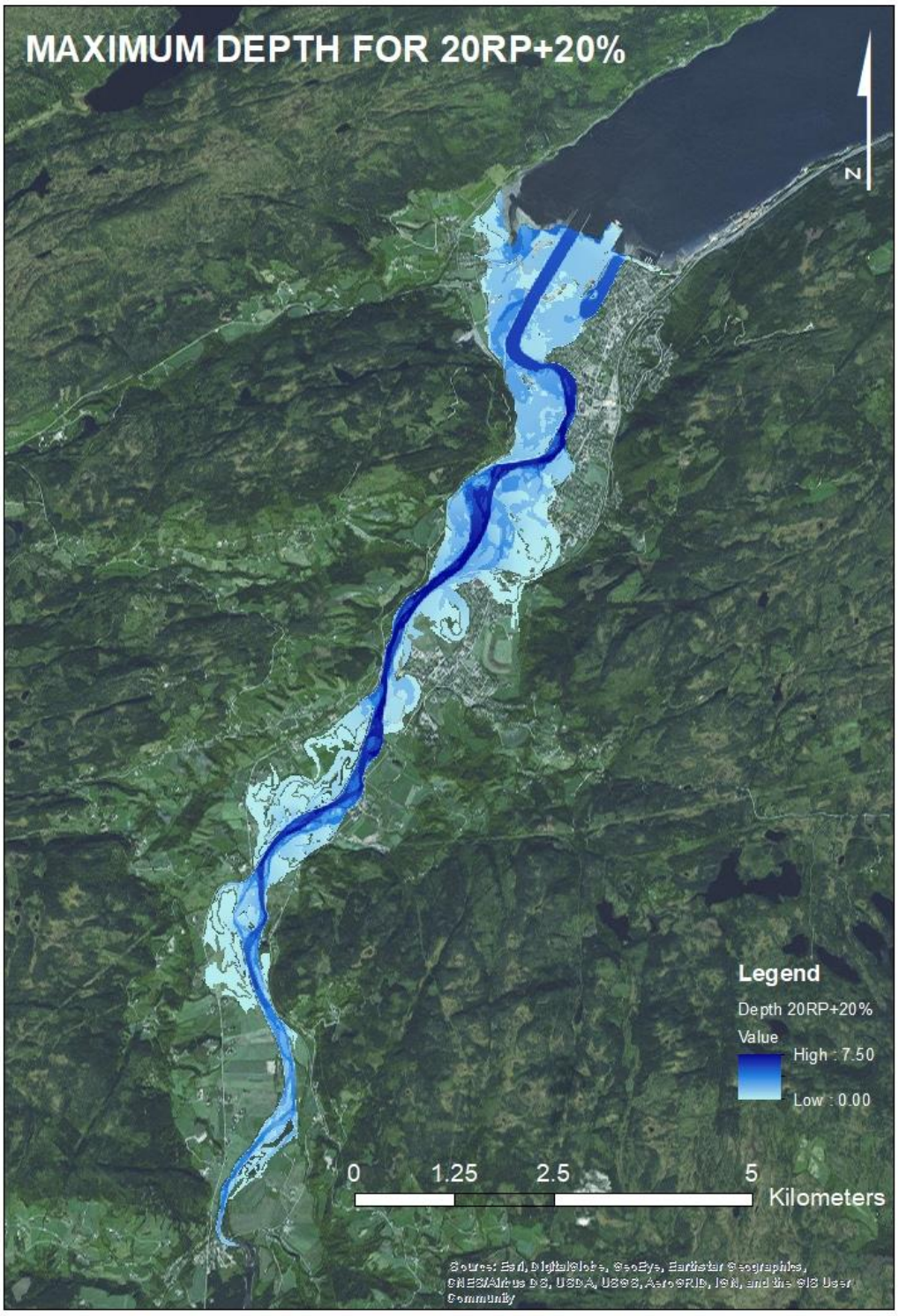

Figure 6: Maximum Depth for 20 years return period +20%

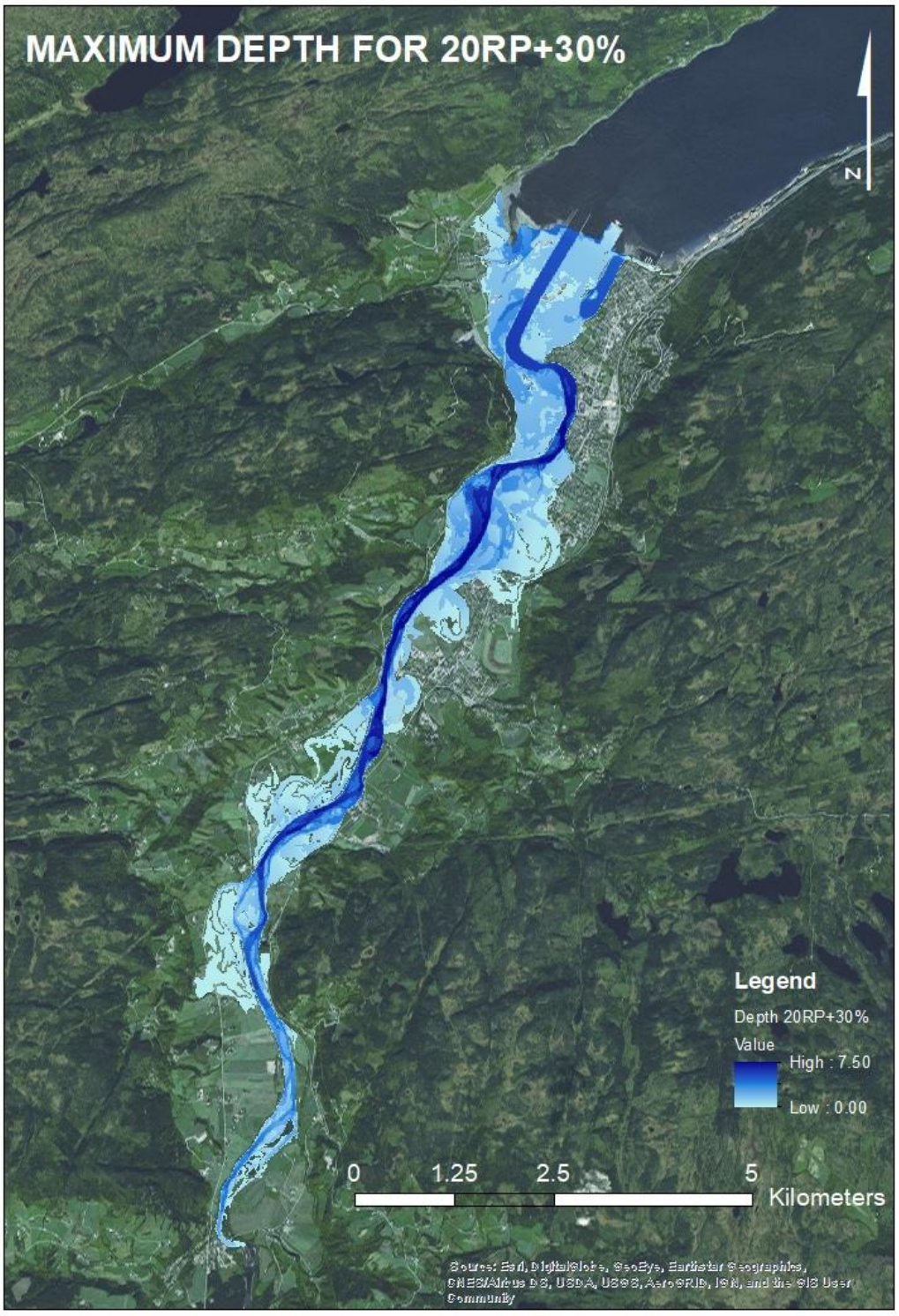

Figure 7: Maximum Depth for 20 years return period +30%

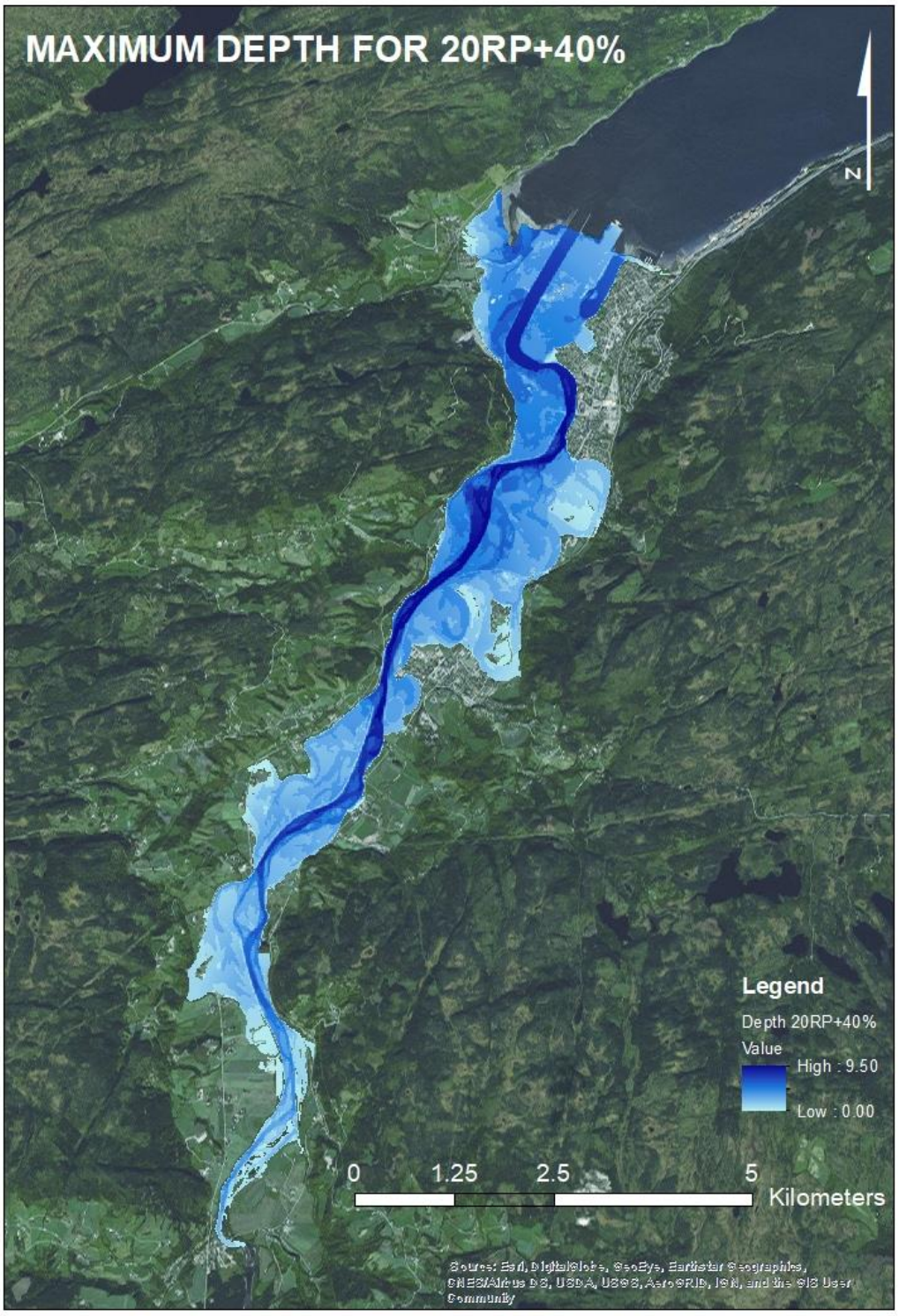

Figure 8: Maximum Depth for 20 years return period +40%

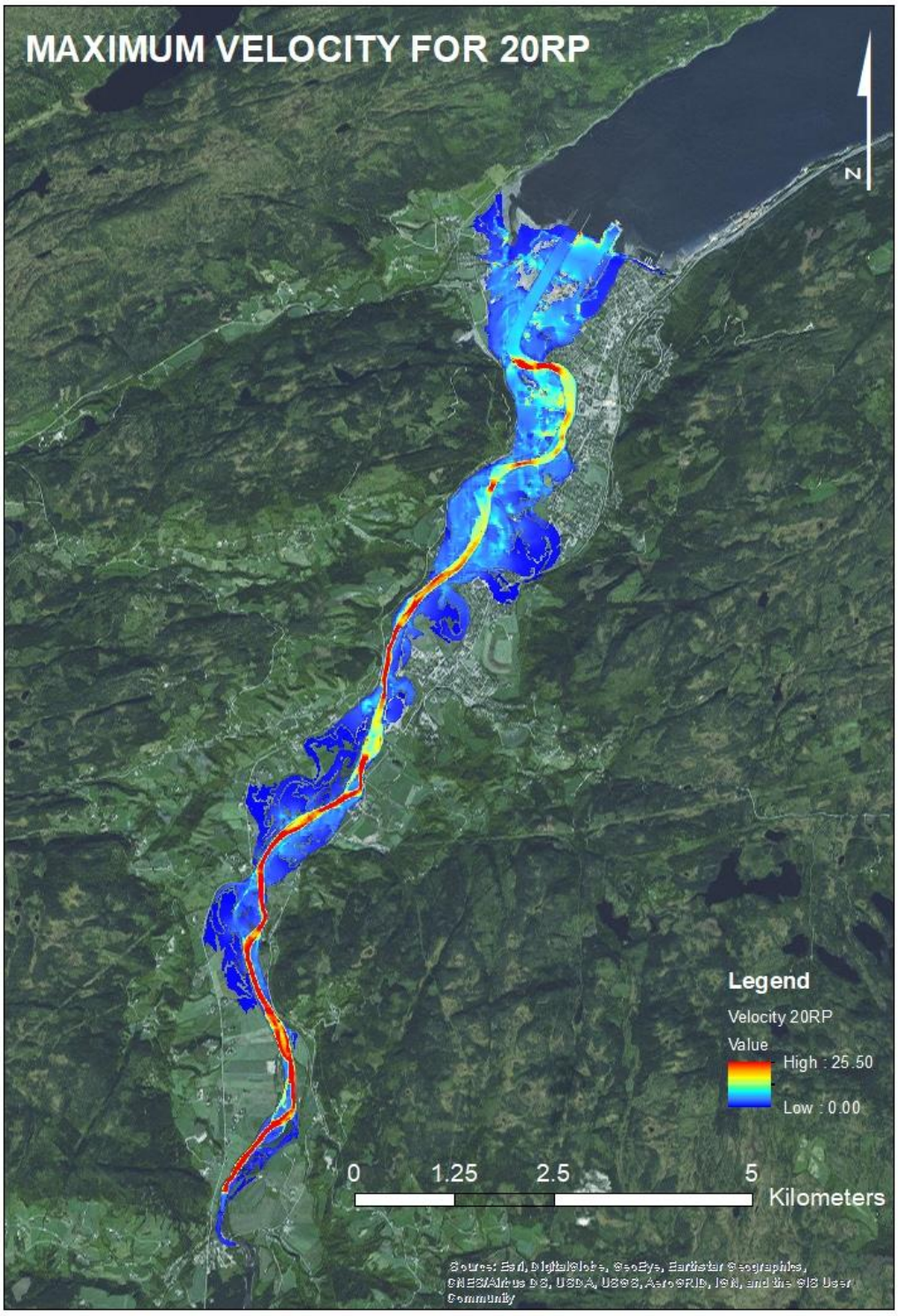

Figure 9: Maximum Velocity for 20 years return period

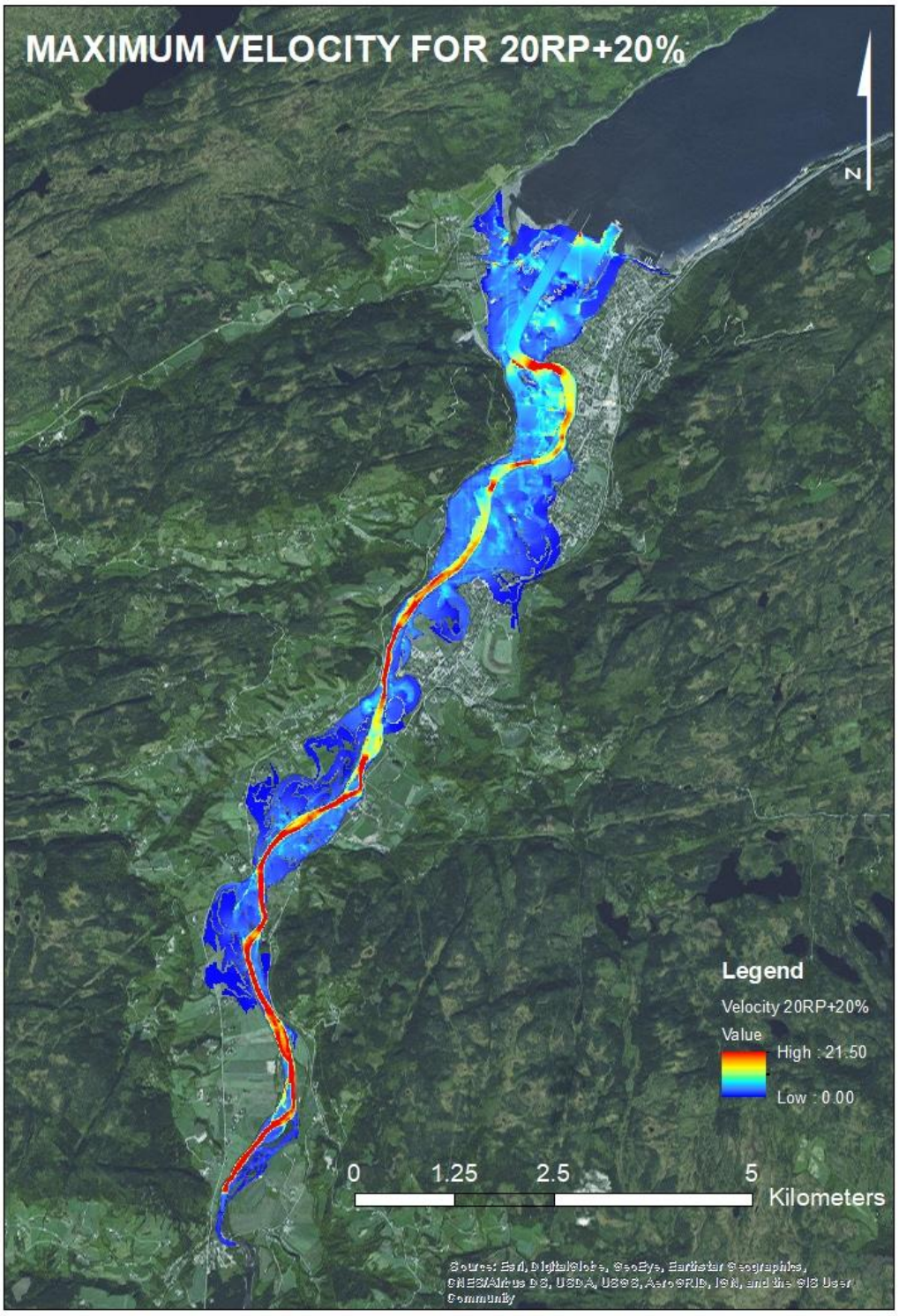

Figure 10: Maximum Velocity for 20 years return period +20%

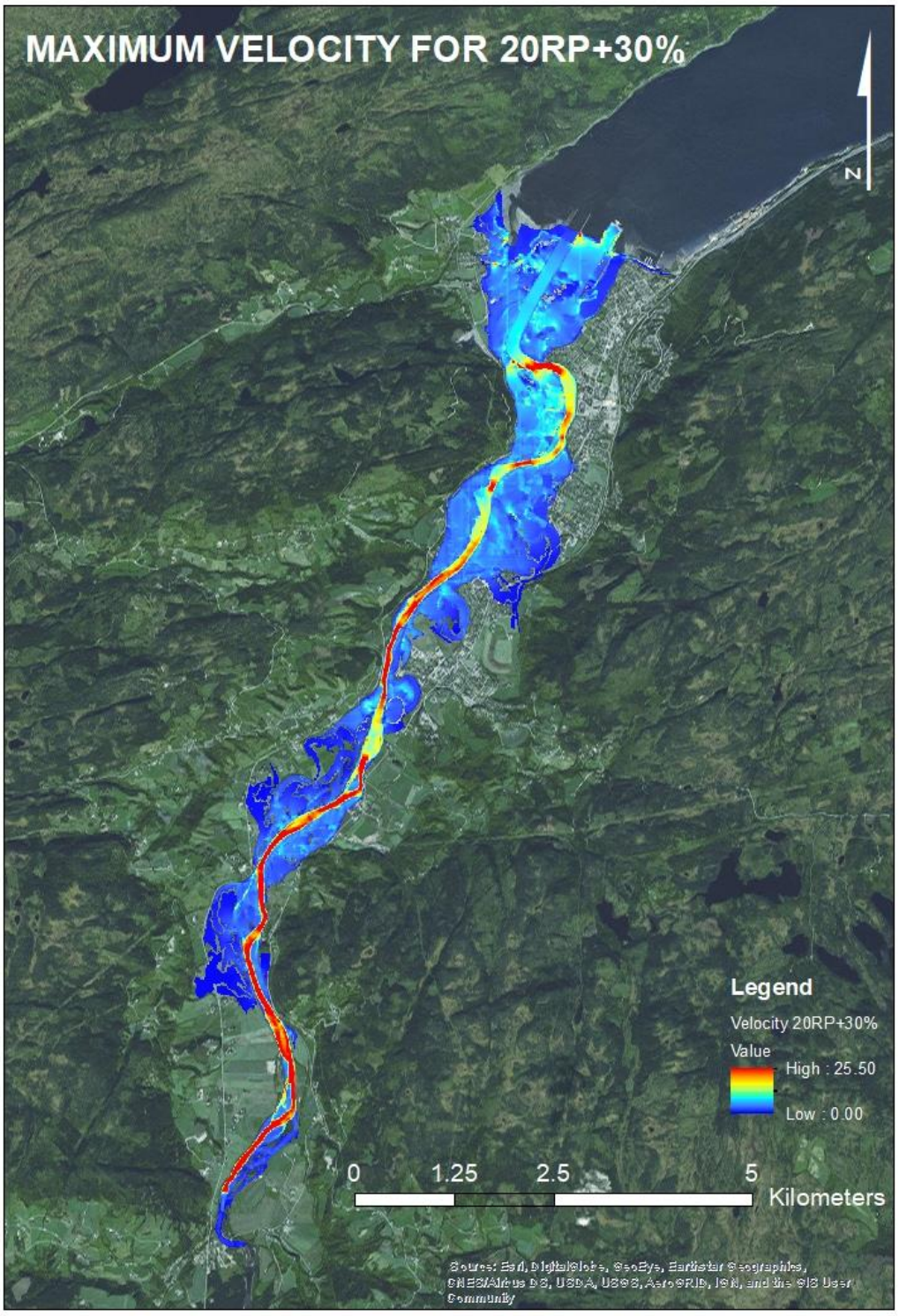

Figure 11: Maximum Velocity for 20 years return period +30%

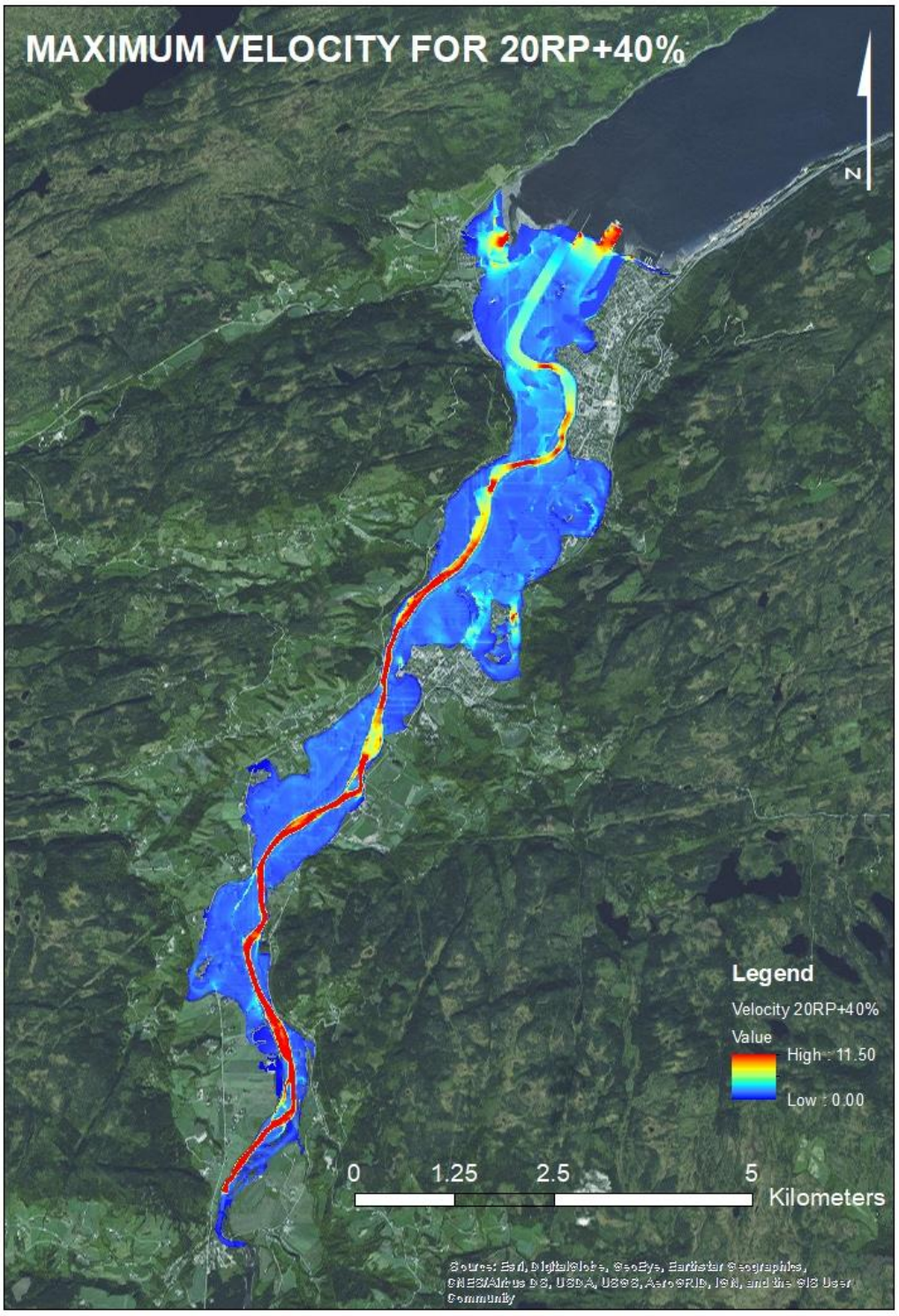

Figure 12: Maximum Velocity for 20 years return period +40%

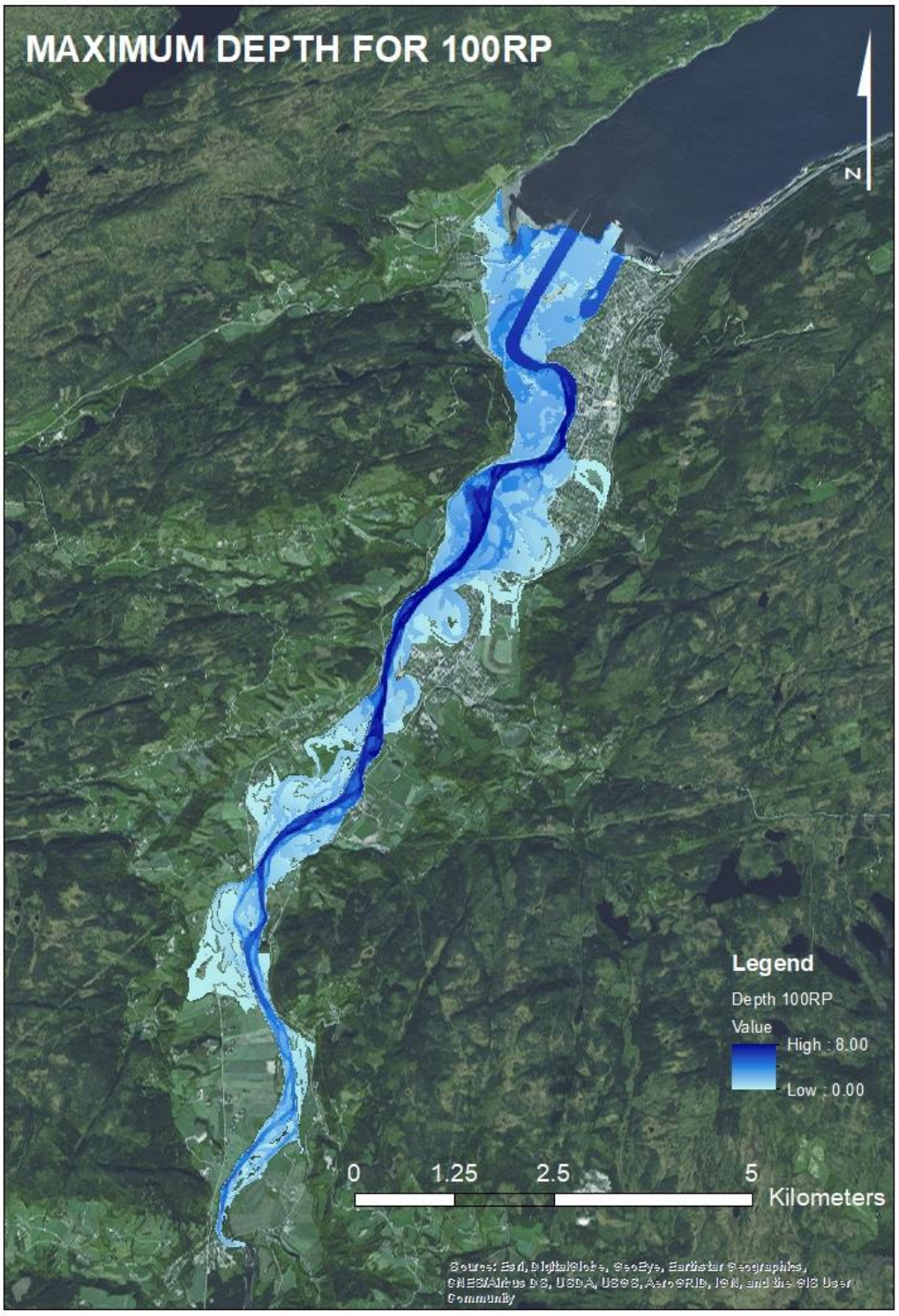

Figure 13: Maximum Depth for 100 years return period

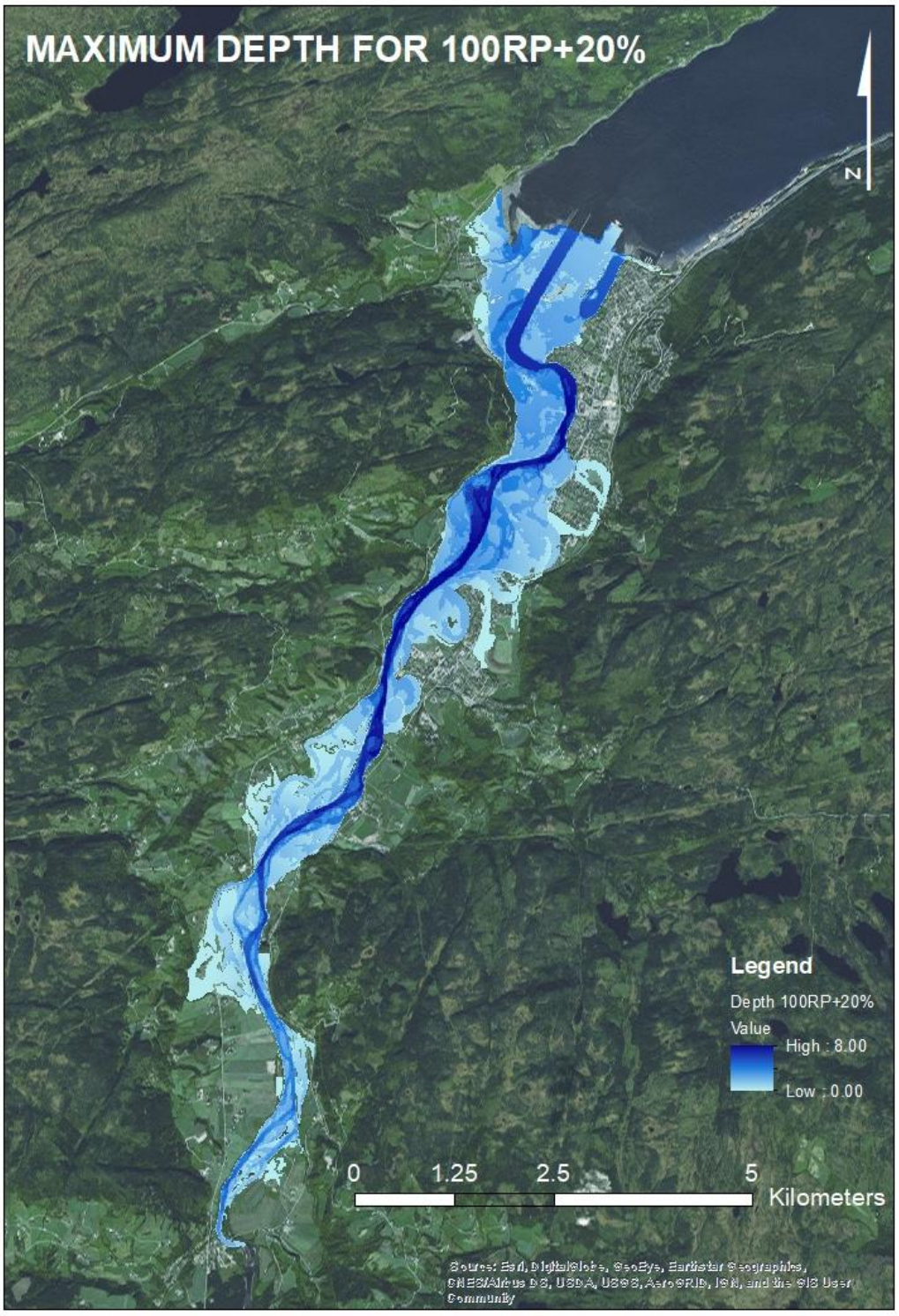

Figure 14: Maximum Depth for 100 years return period +20%

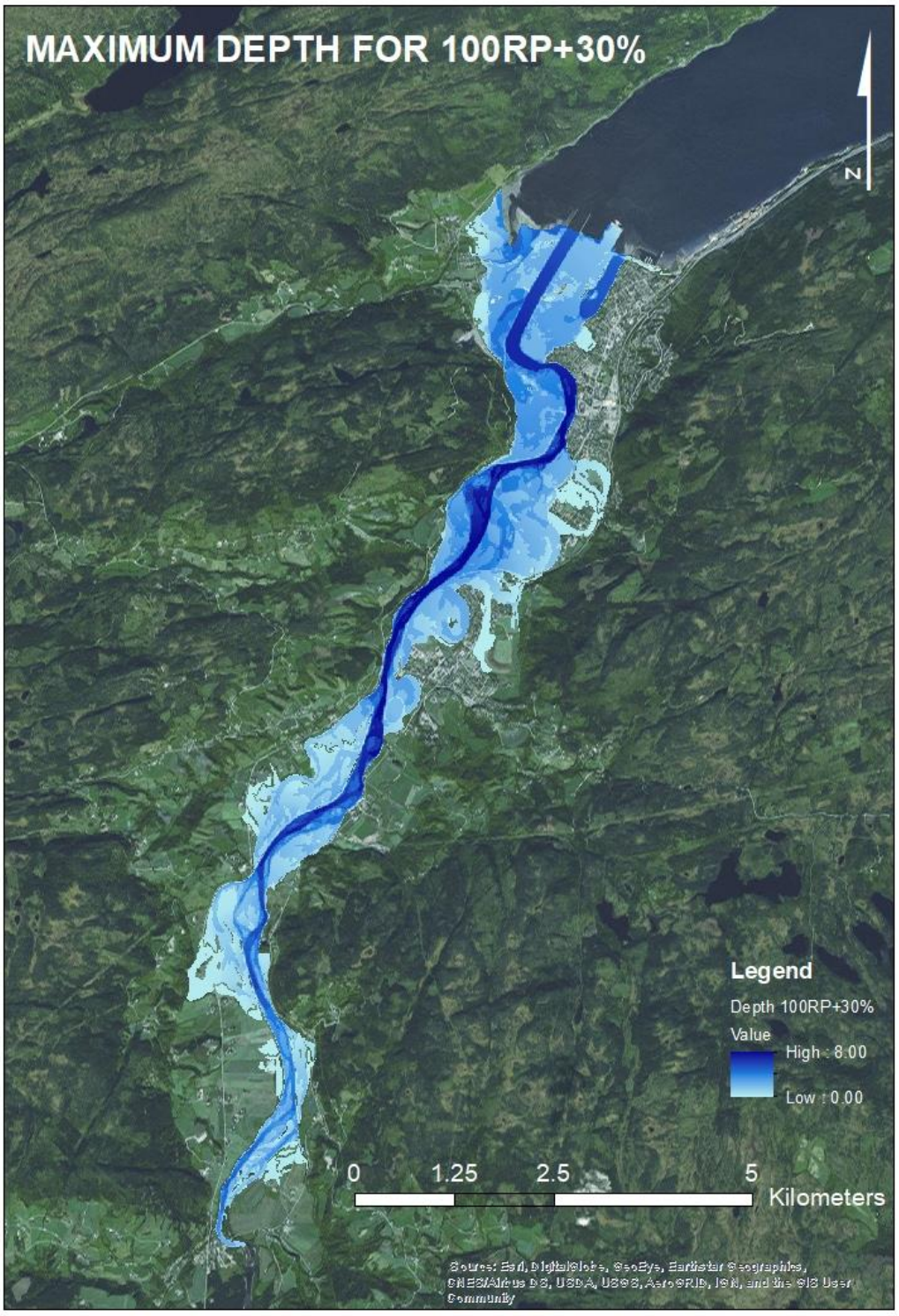

Figure 15: Maximum Depth for 100 years return period +30%

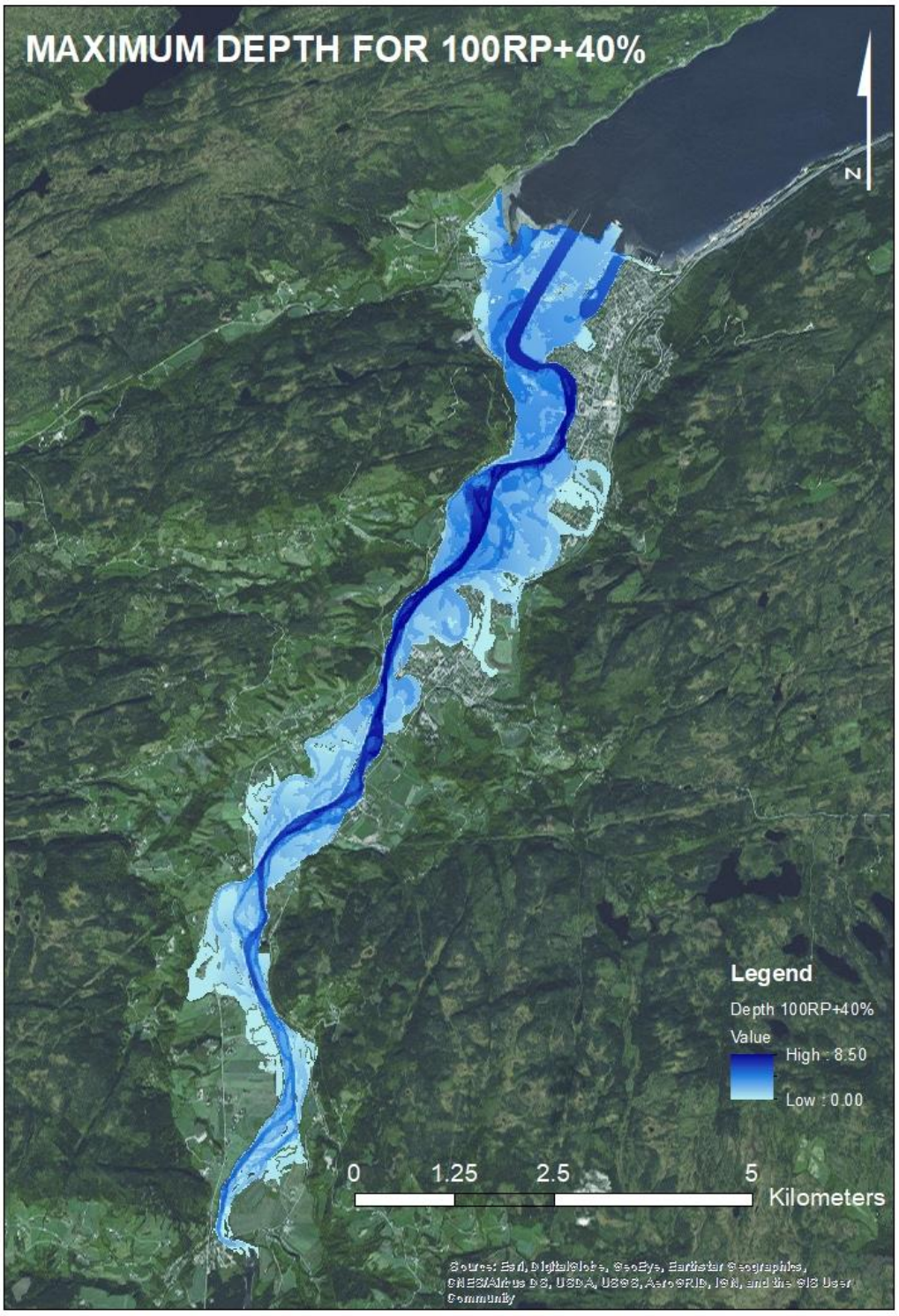

Figure 16: Maximum Depth for 100 years return period +40%

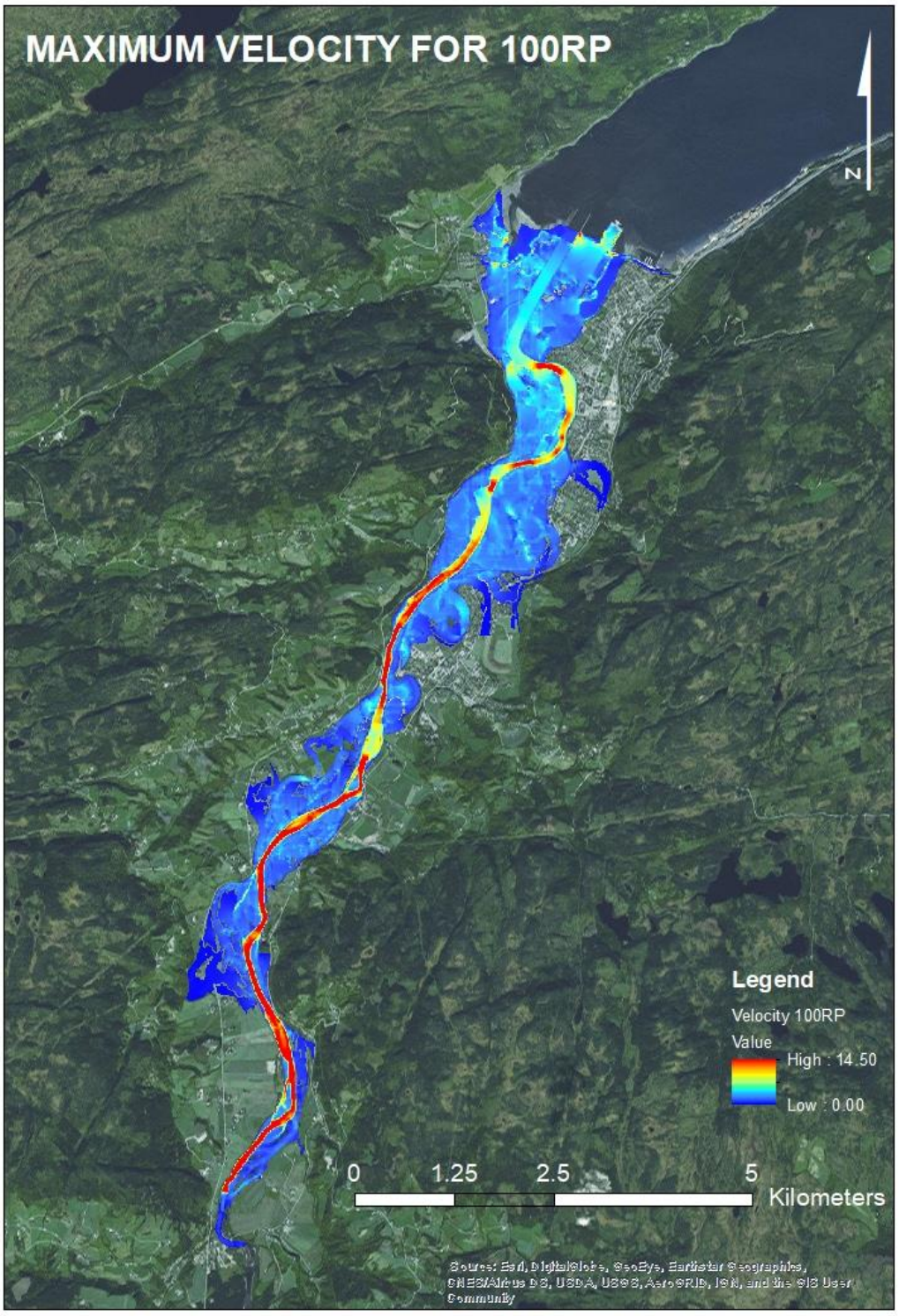

Figure 17: Maximum Velocity for 100 years return period

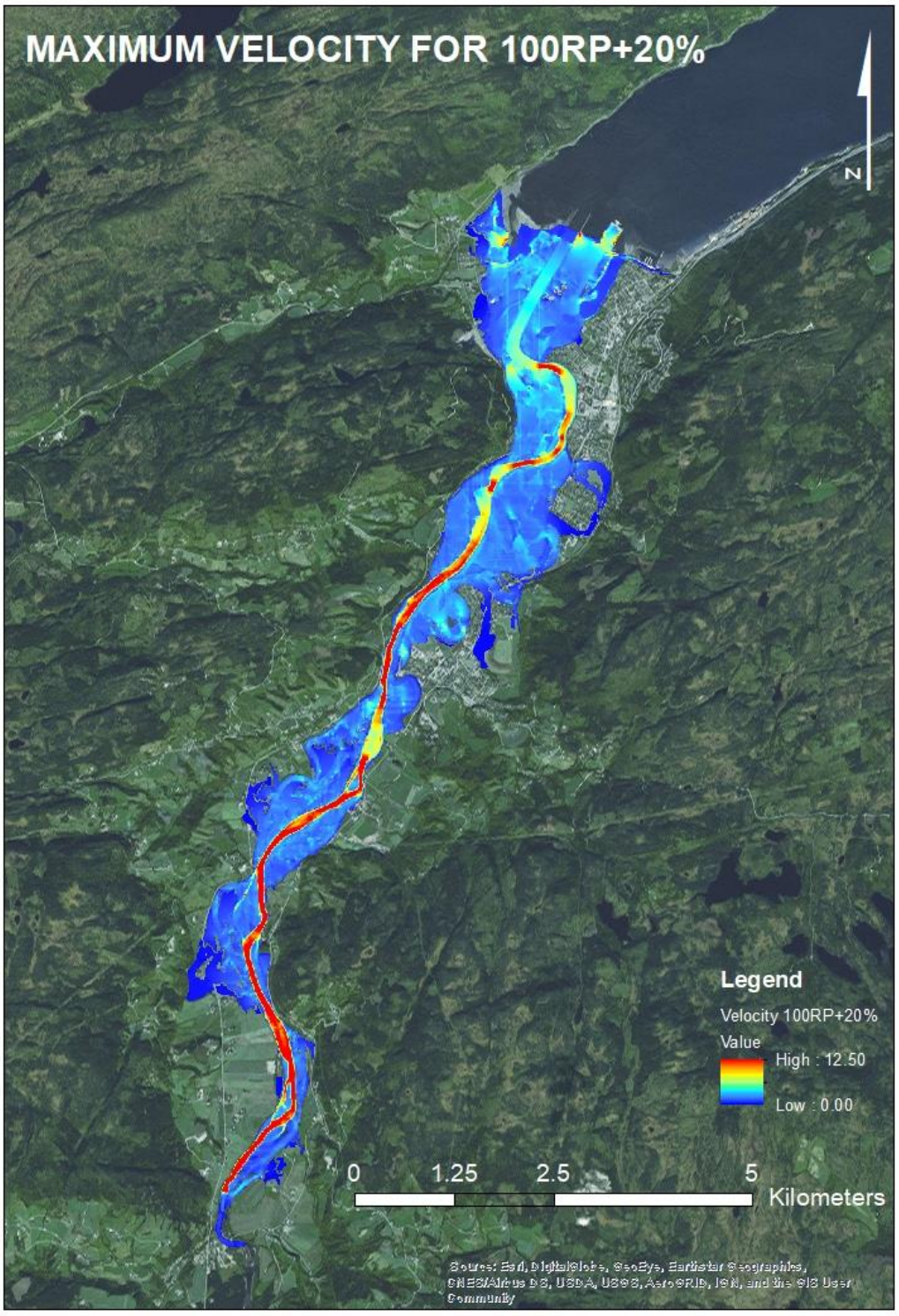

Figure 18: Maximum Velocity for 100 years return period +20%

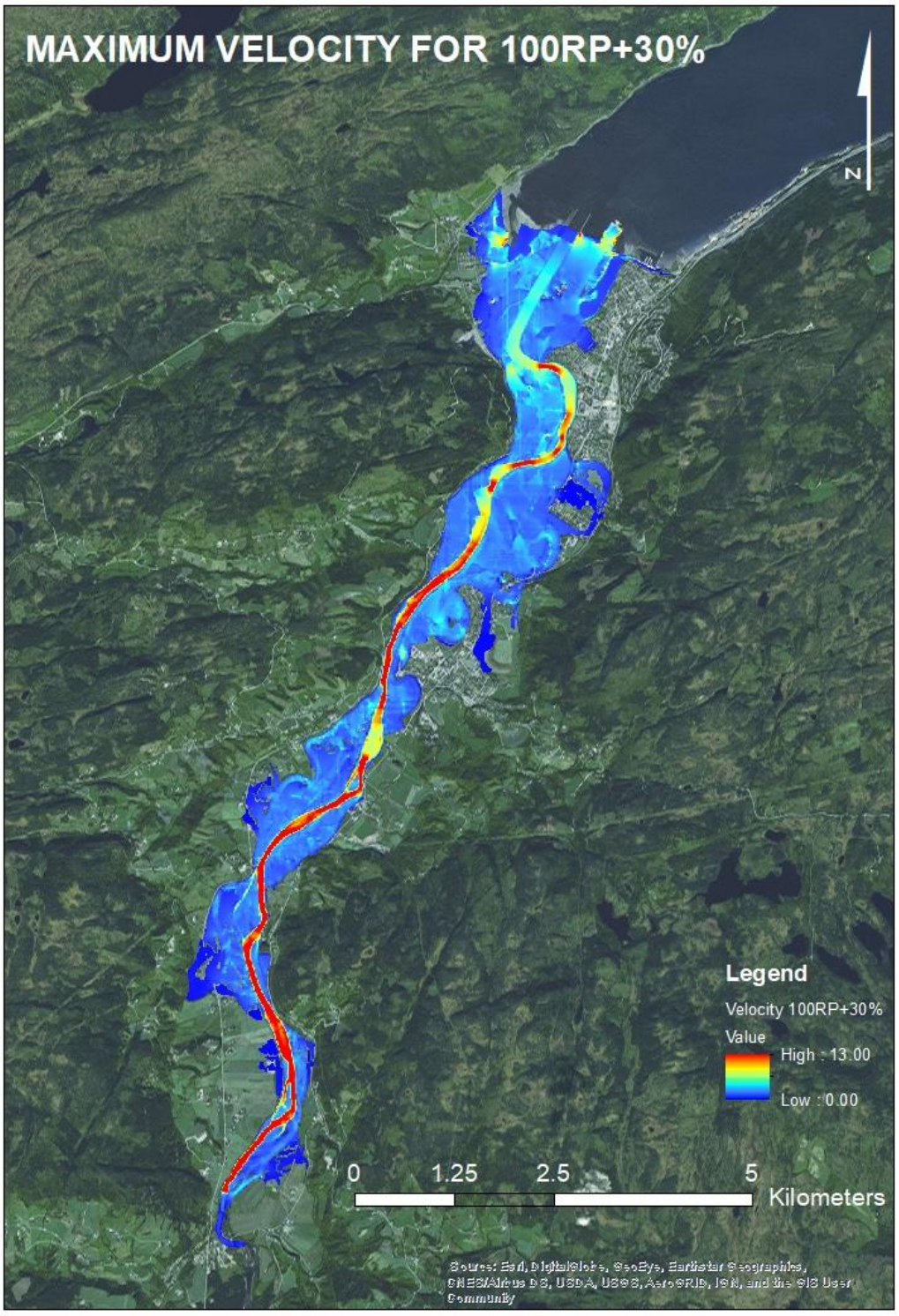

Figure 19: Maximum Velocity for 100 years return period +30%

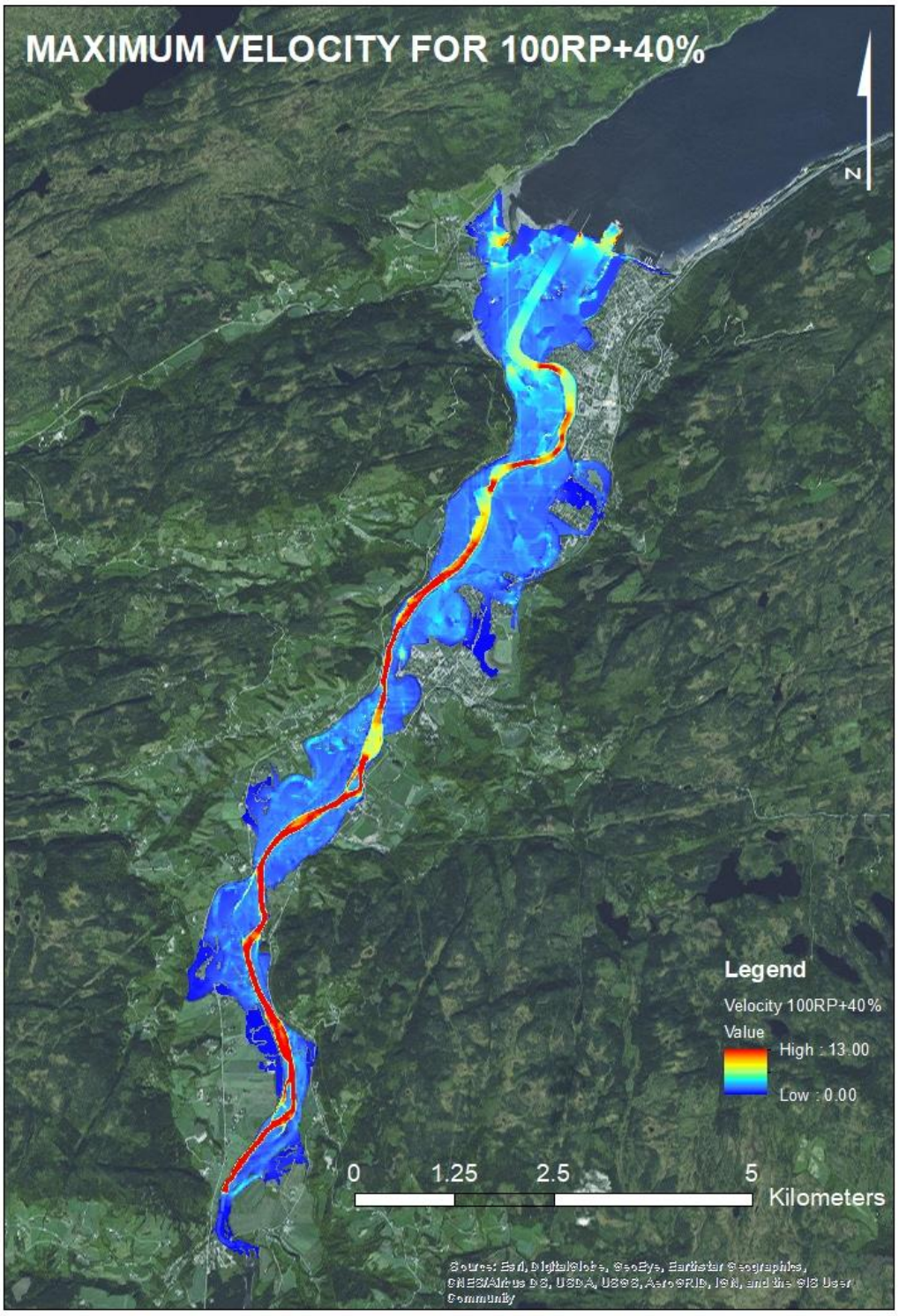

Figure 20: Maximum Velocity for 100 years return period +40%

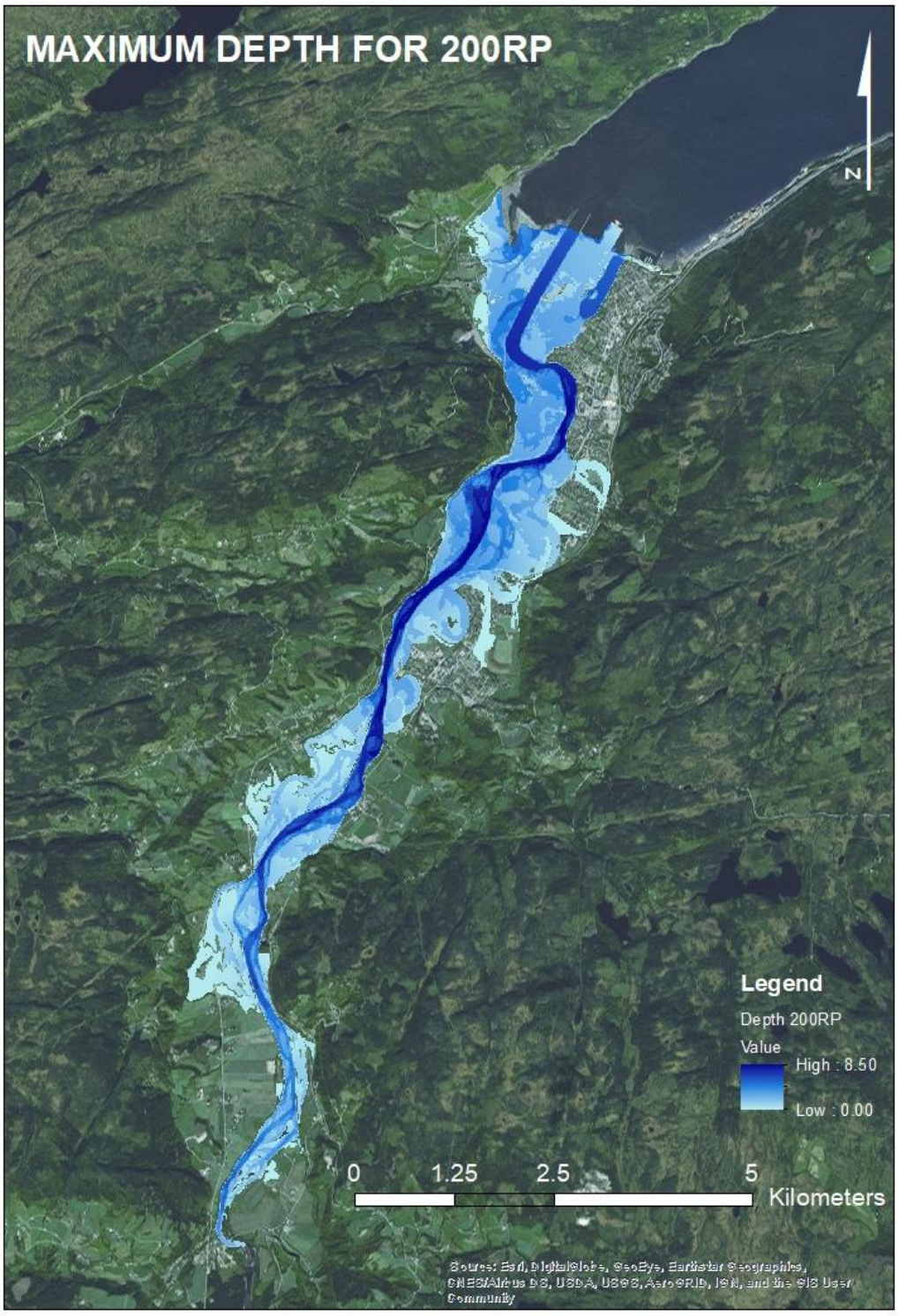

Figure 21: Maximum Depth for 200 years return period

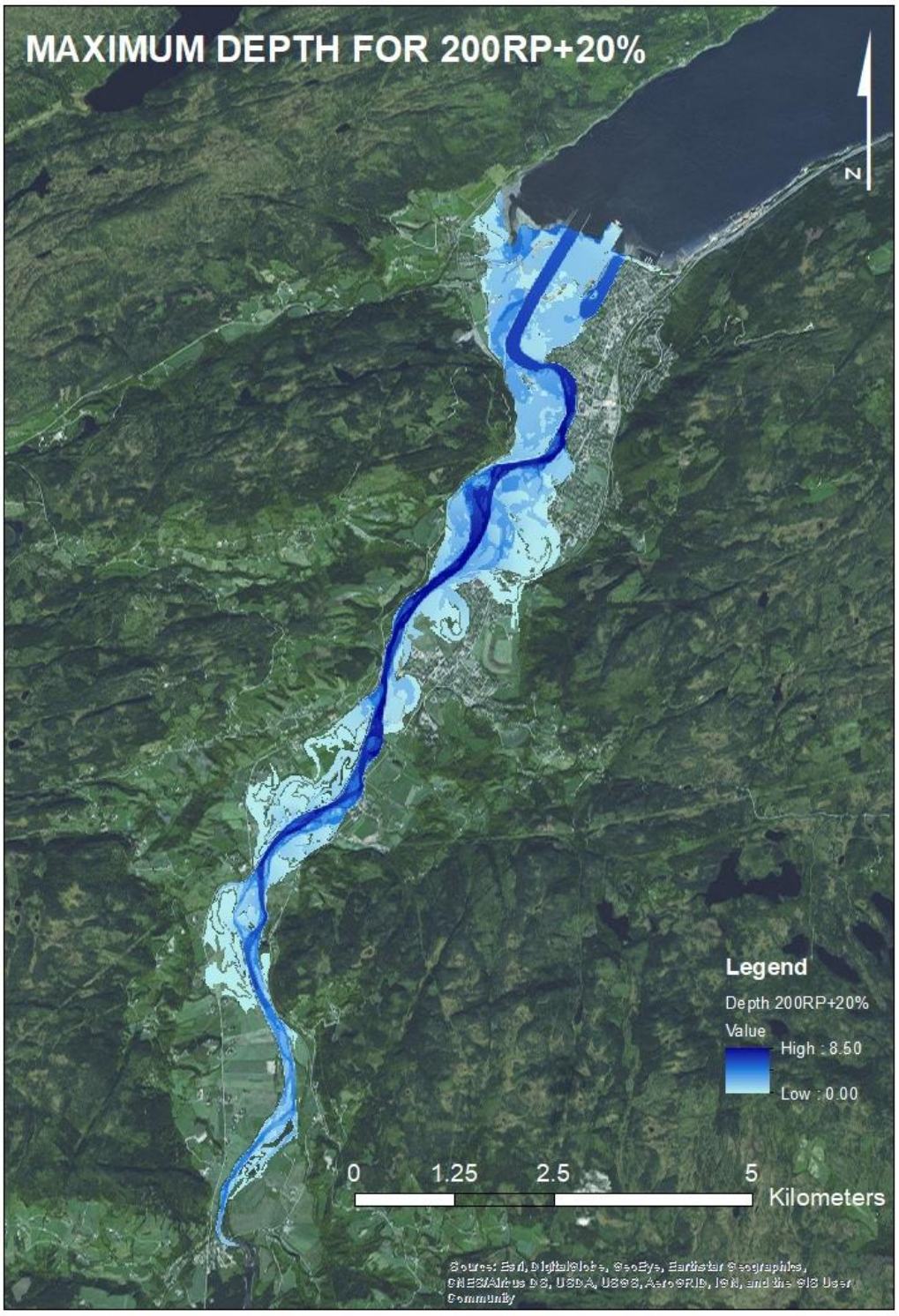

Figure 22: Maximum Depth for 200 years return period +20%

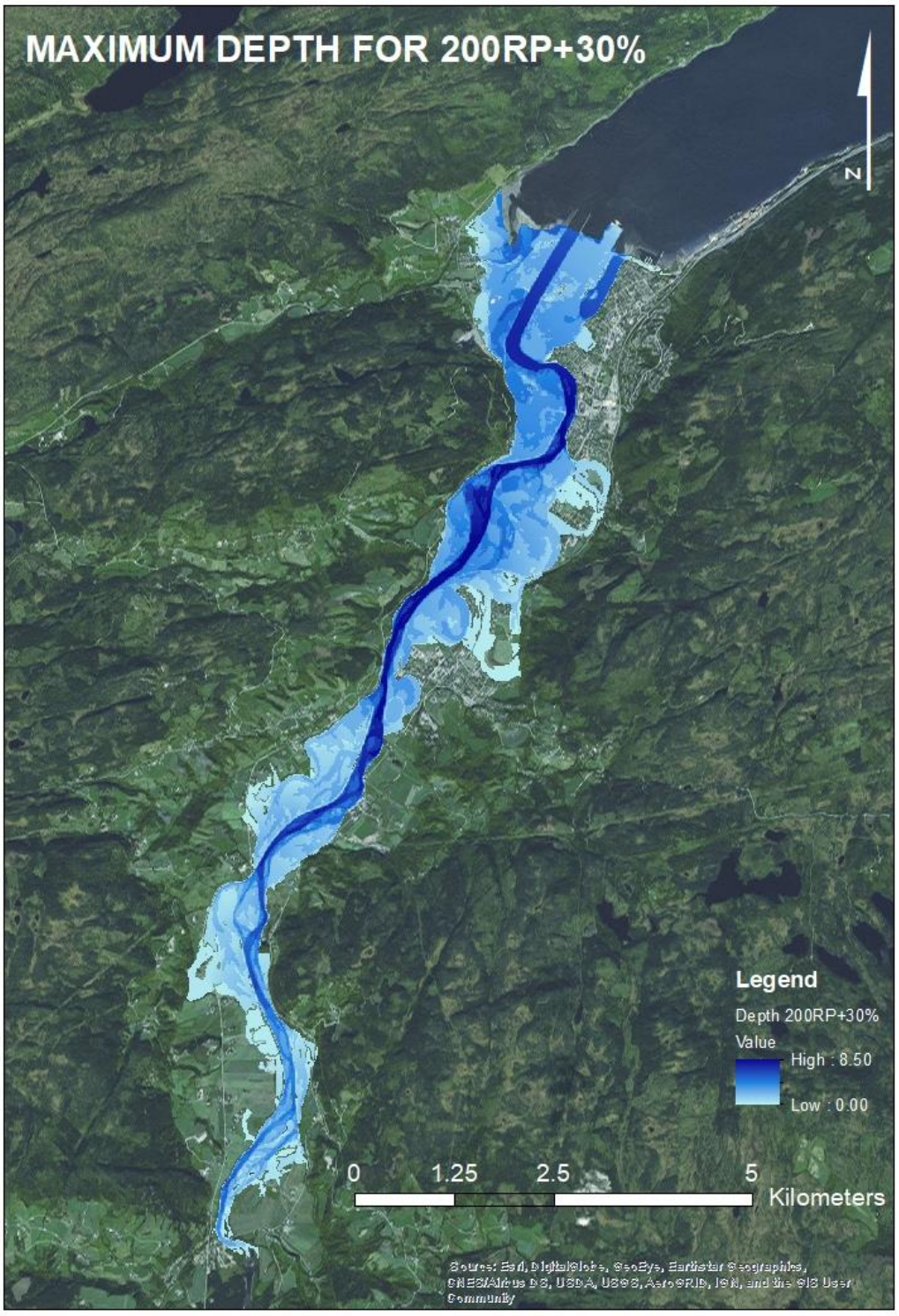

Figure 23: Maximum Depth for 200 years return period +30%

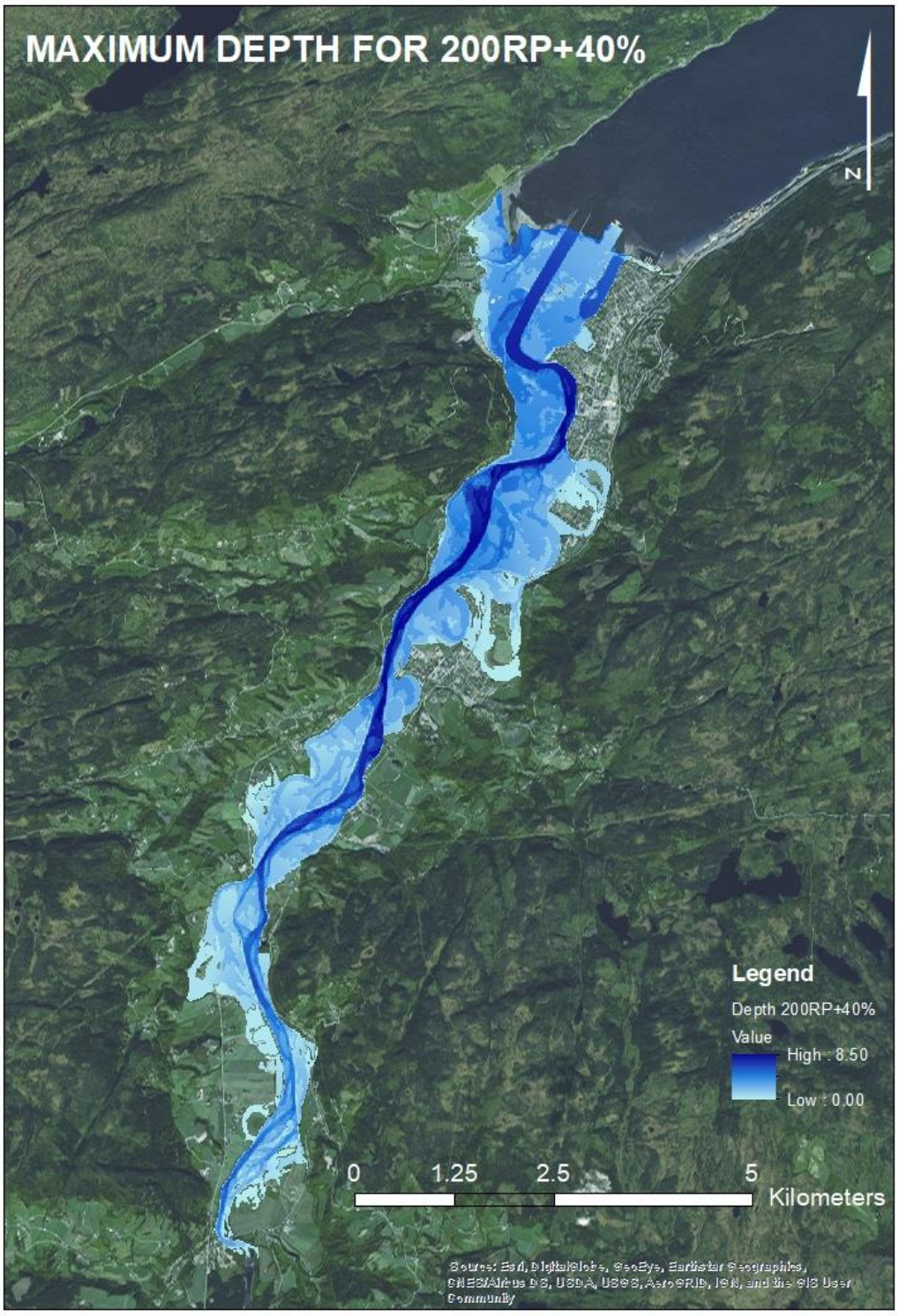

Figure 24: Maximum Depth for 200 years return period +40%

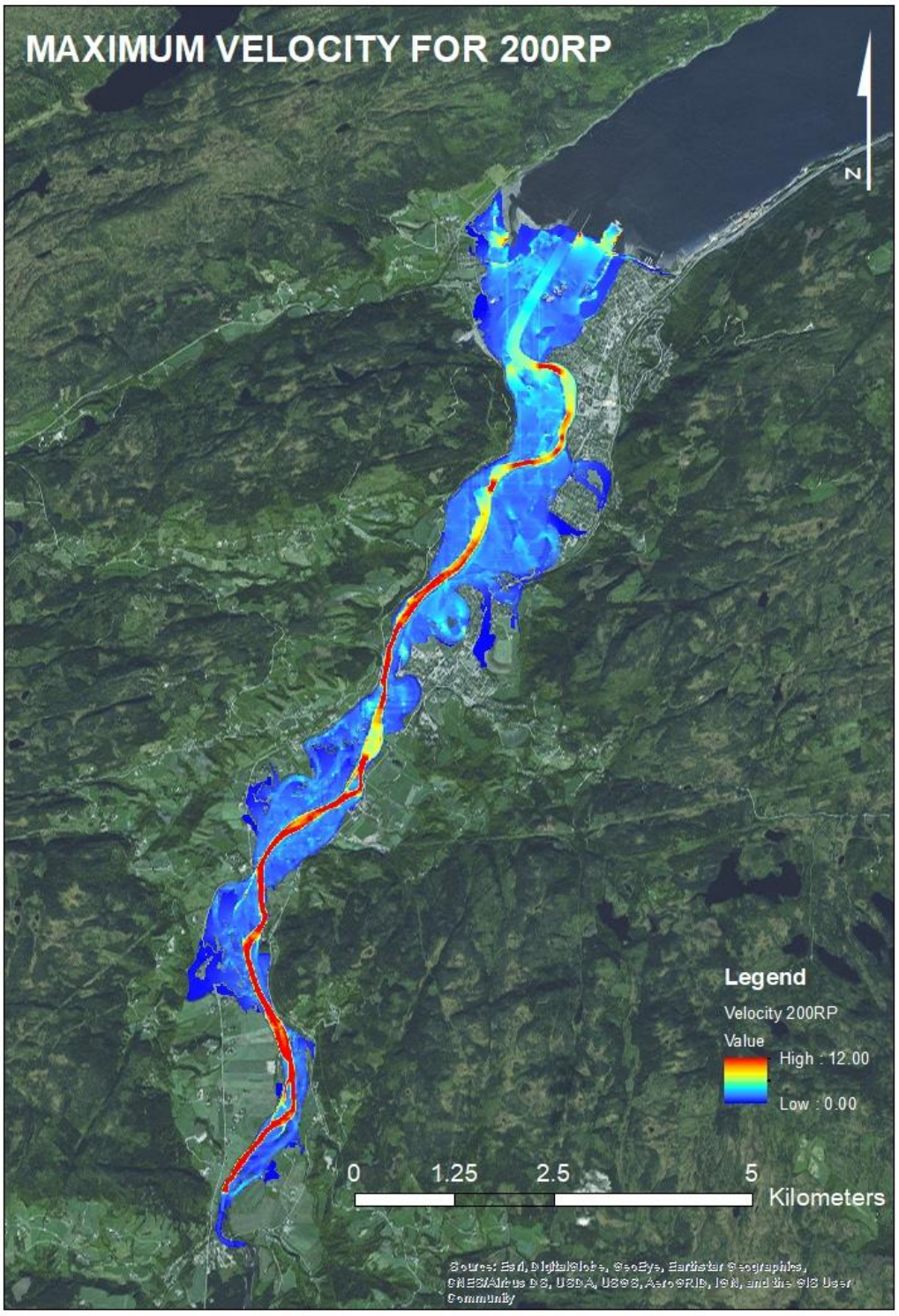

Figure 25: Maximum Velocity for 200 years return period

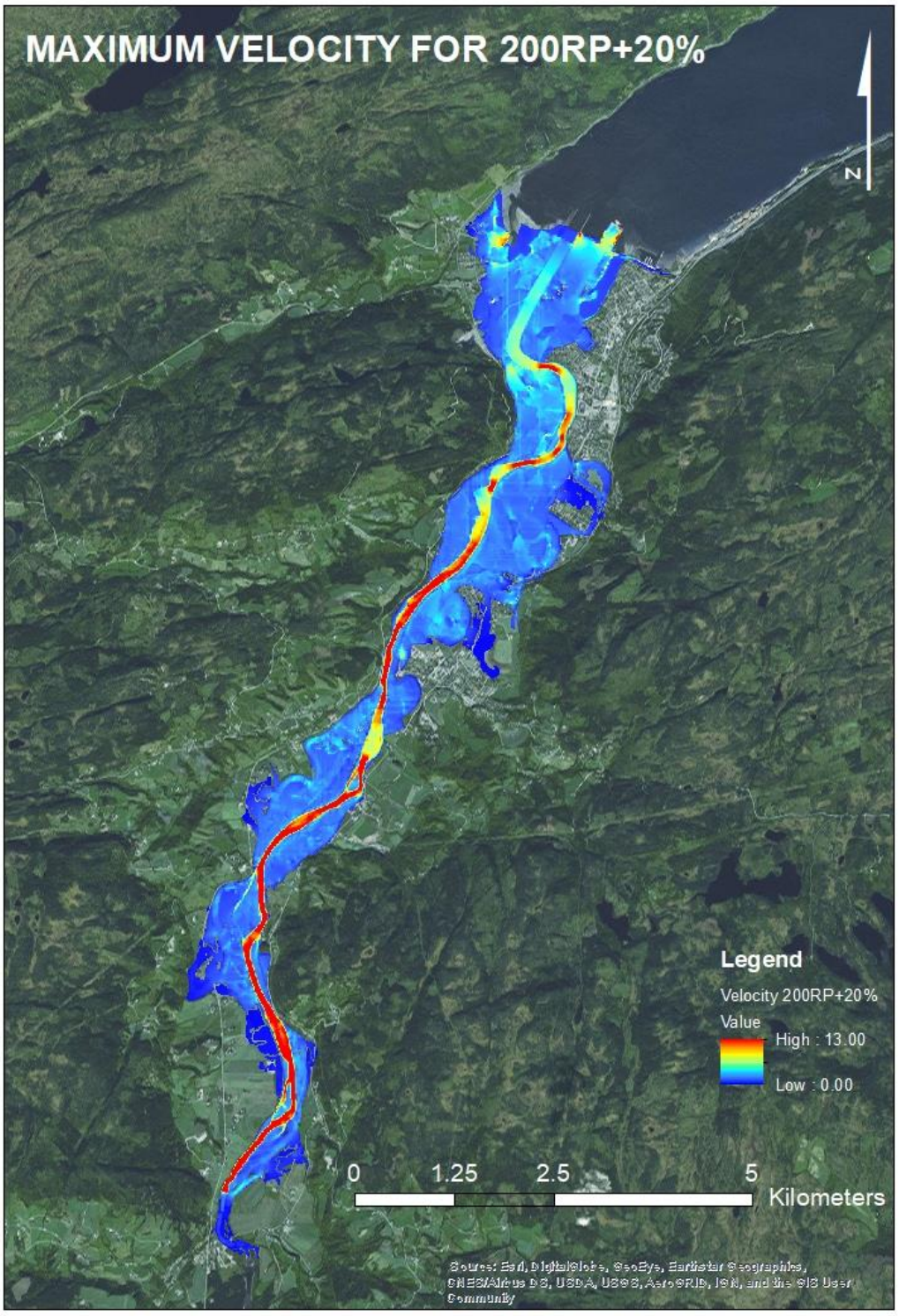

Figure 26: Maximum Velocity for 200 years return period +20%

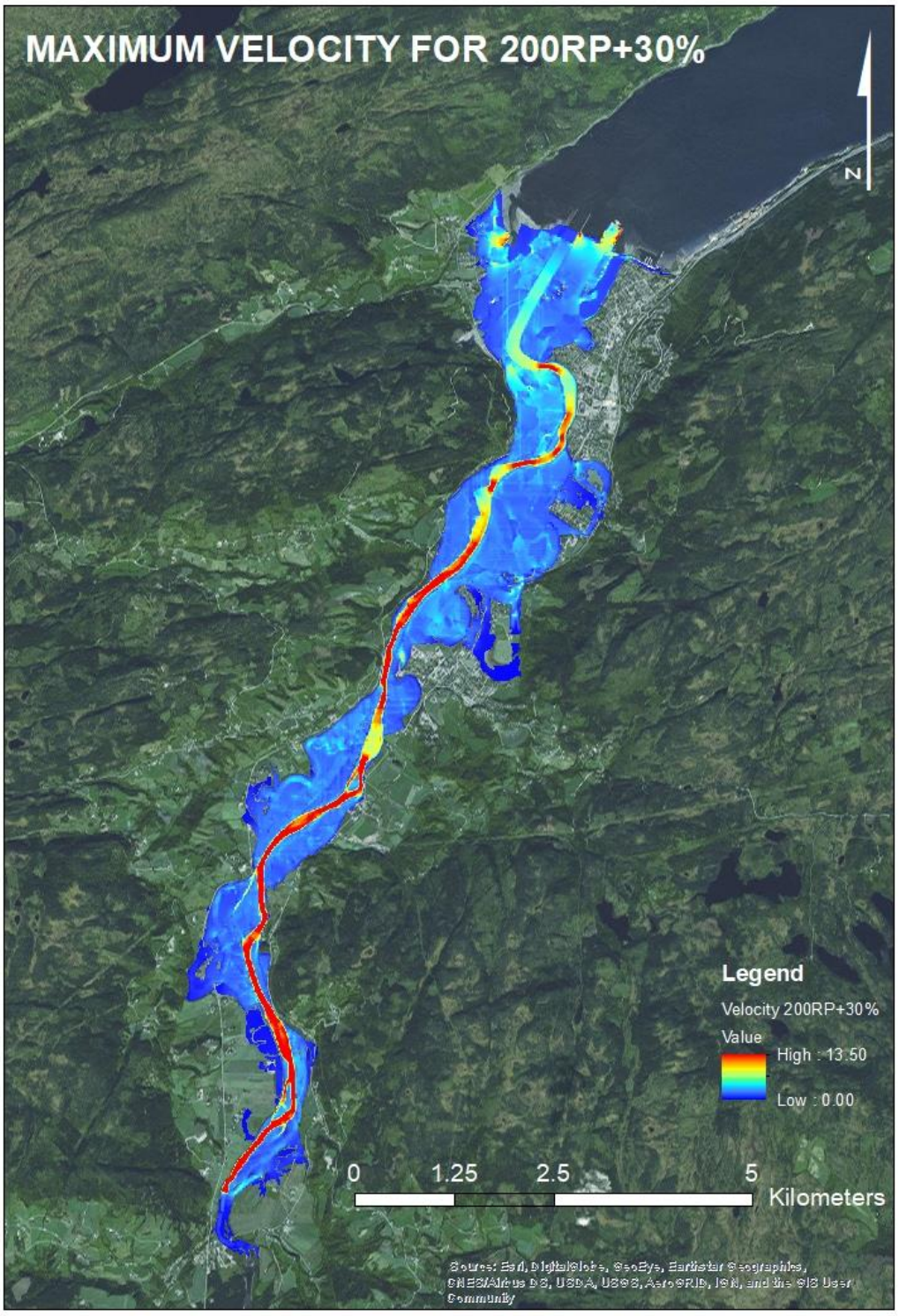

Figure 27: Maximum Velocity for 200 years return period +30%

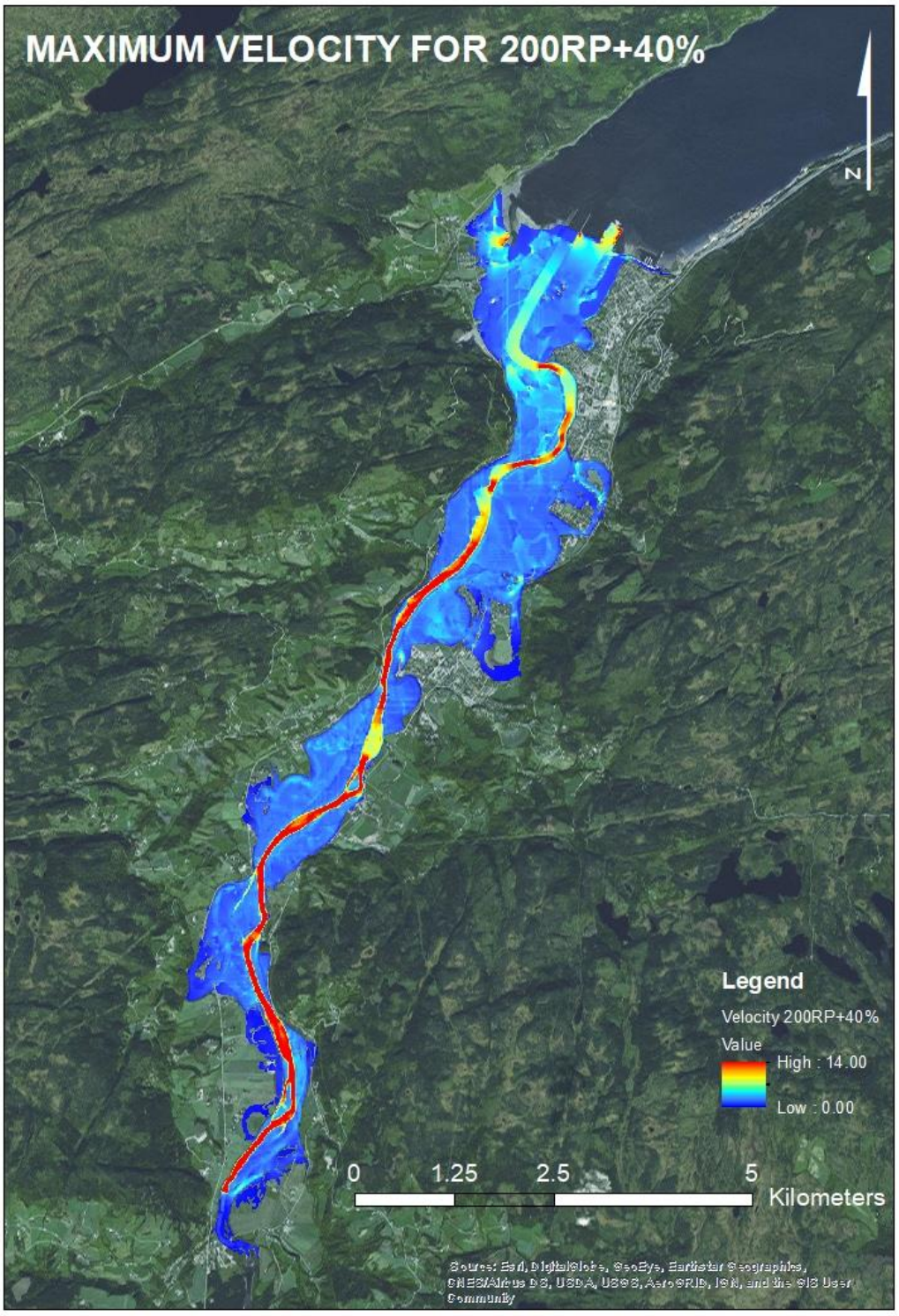

Figure 28: Maximum Velocity for 200 years return period +40%

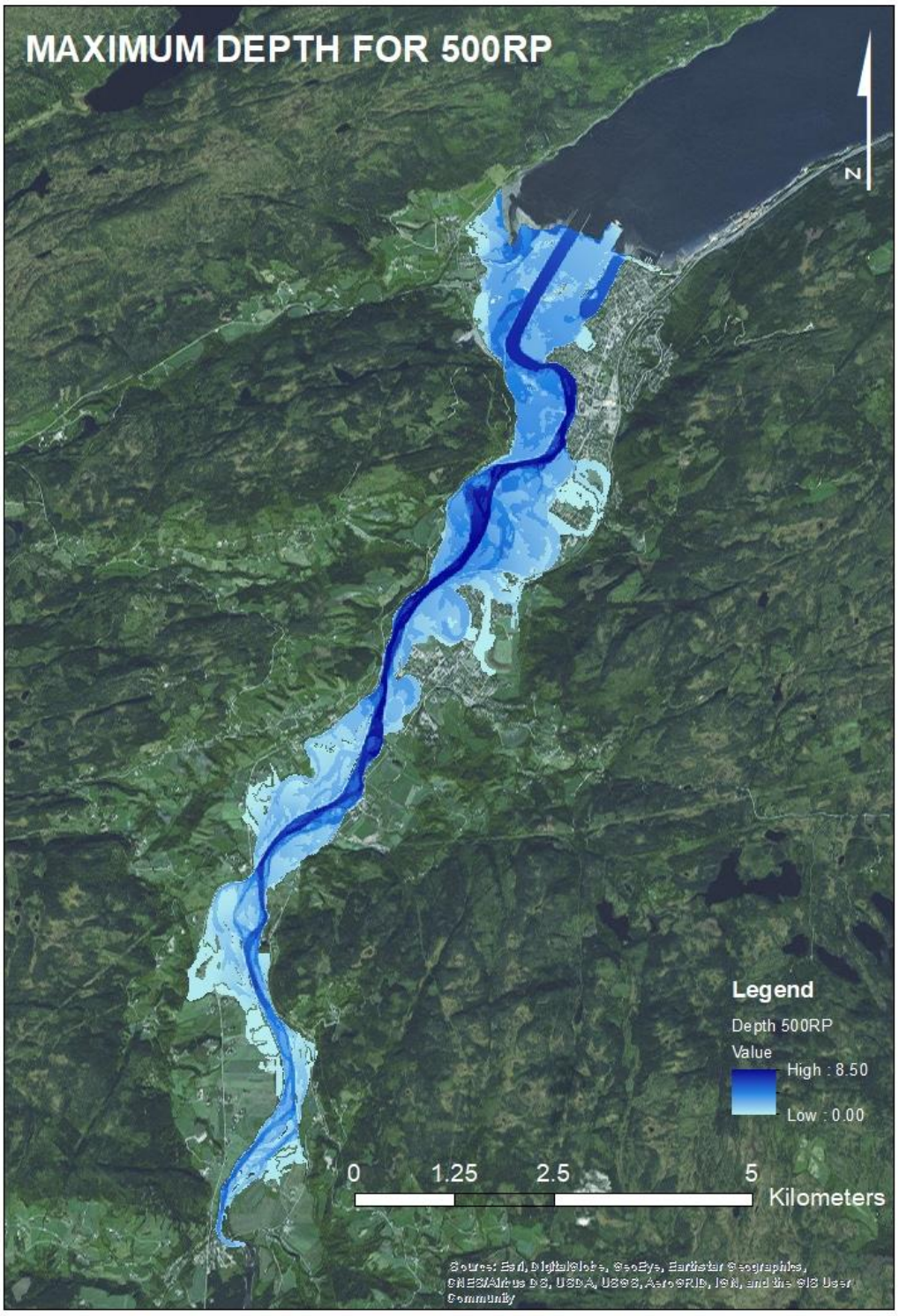

Figure 29: Maximum Depth for 500 years return period

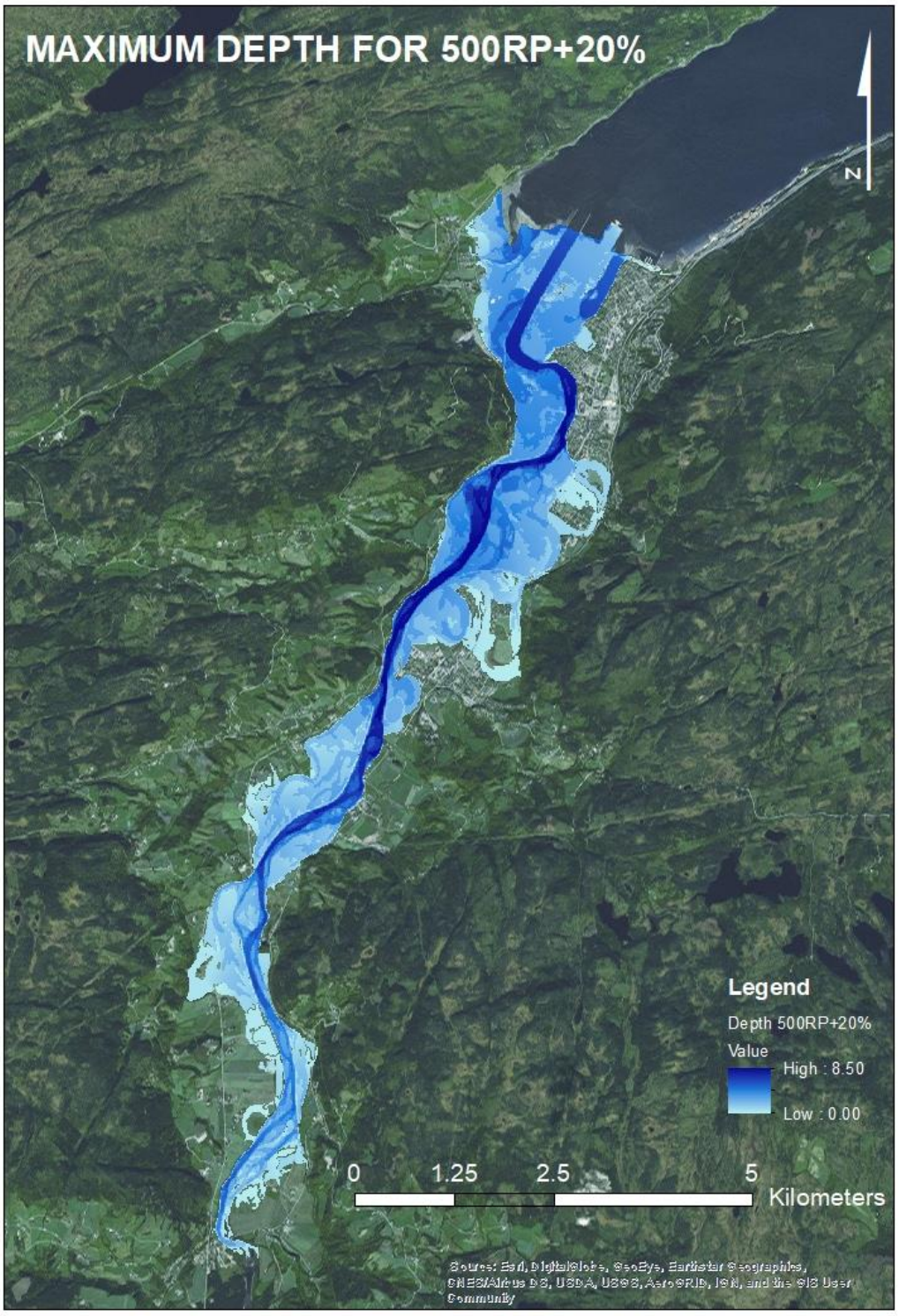

Figure 30: Maximum Depth for 500 years return period +20%

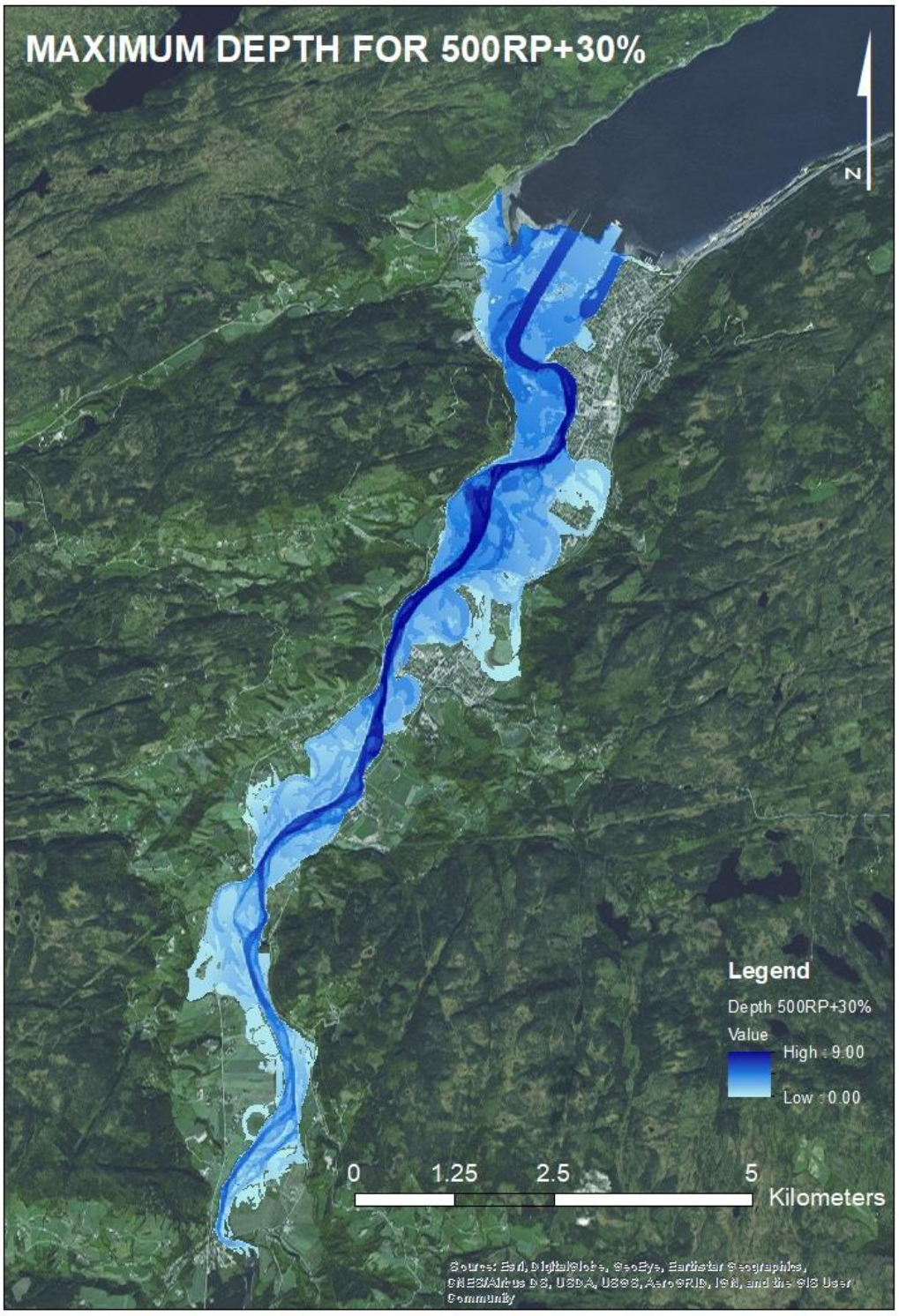

Figure 31: Maximum Depth for 500 years return period +30%

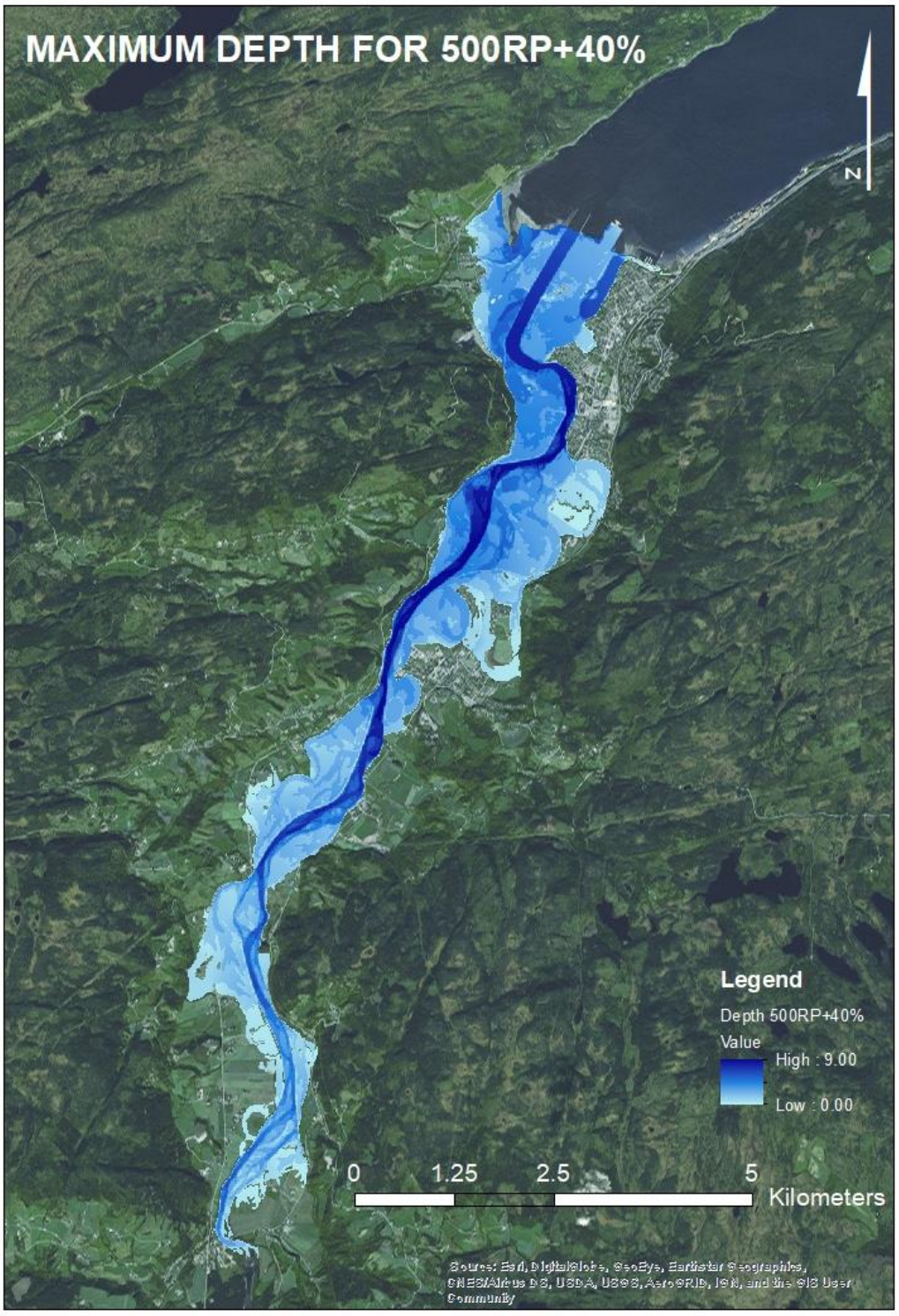

Figure 32: Maximum Depth for 500 years return period +40%

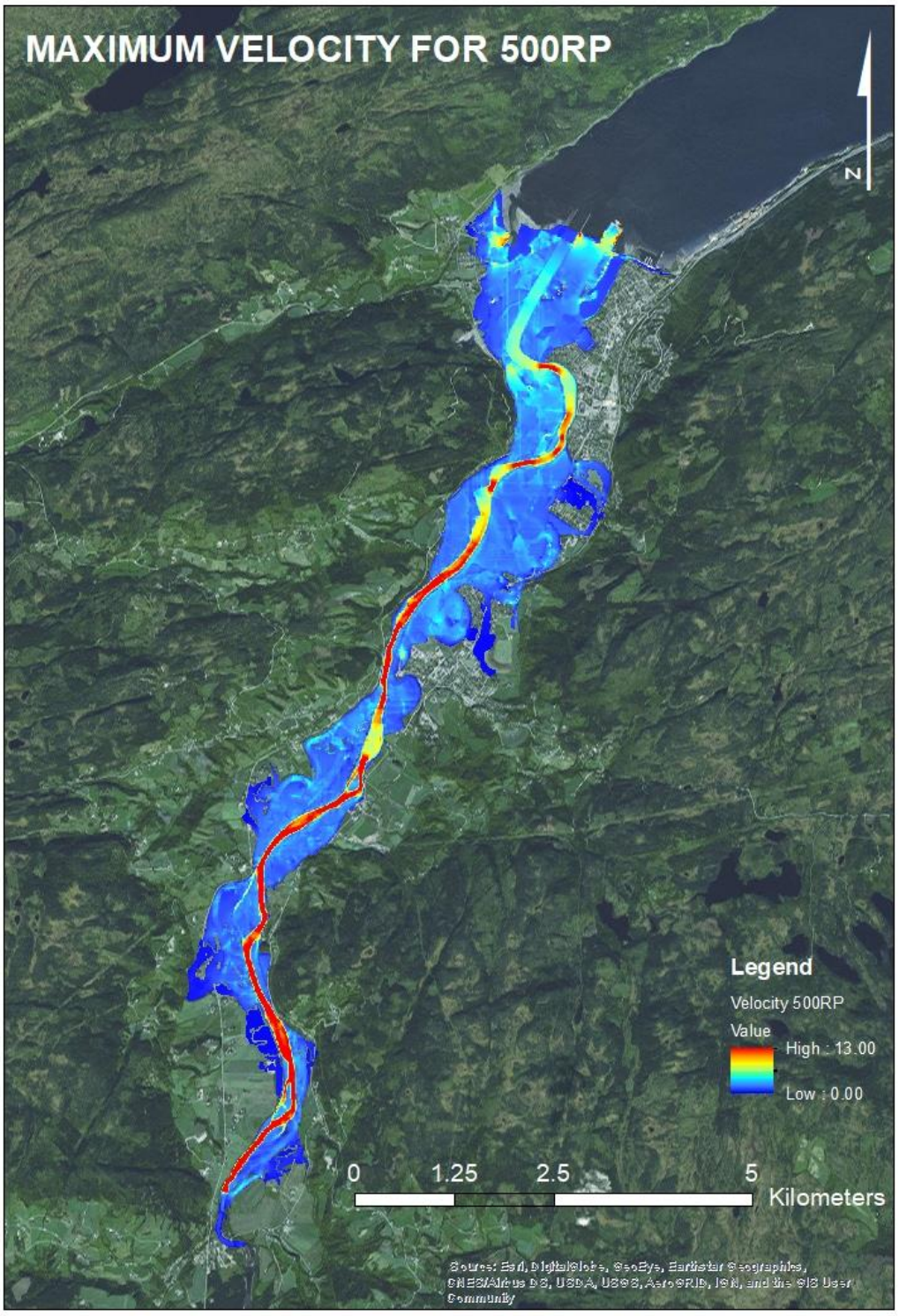

Figure 33: Maximum Velocity for 500 years return period

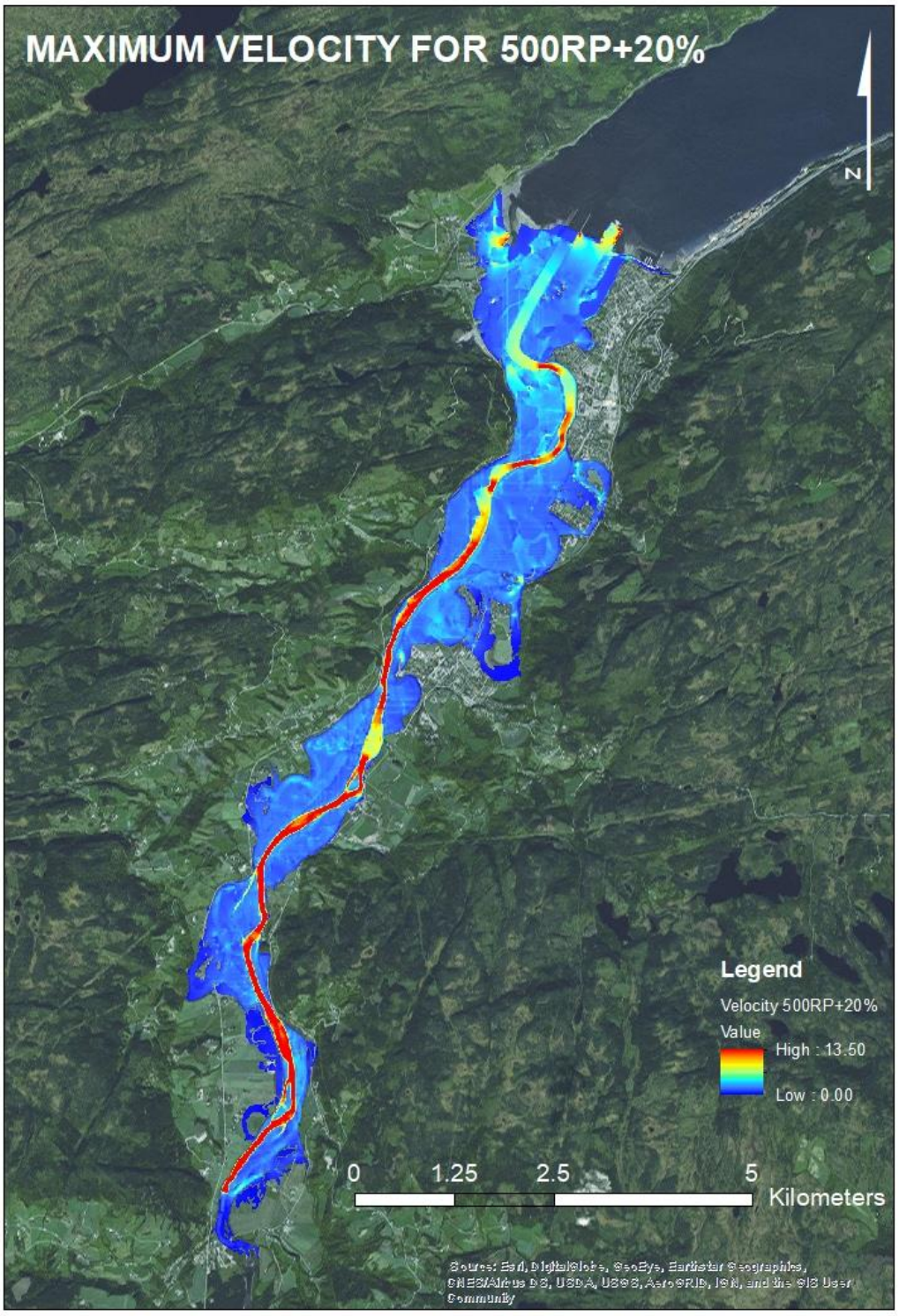

Figure 34: Maximum Velocity for 500 years return period +20%

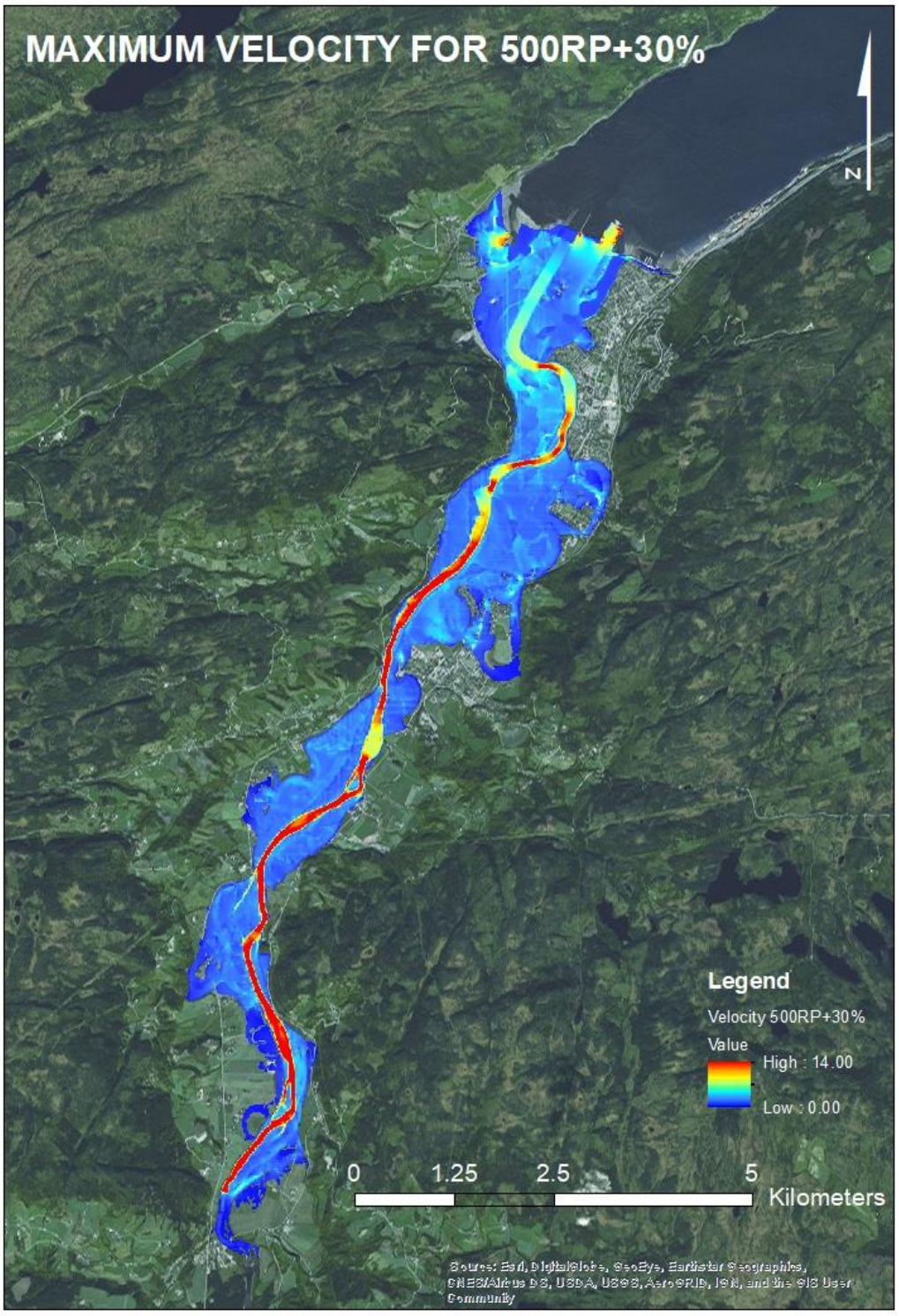

Figure 35: Maximum Velocity for 500 years return period +30%

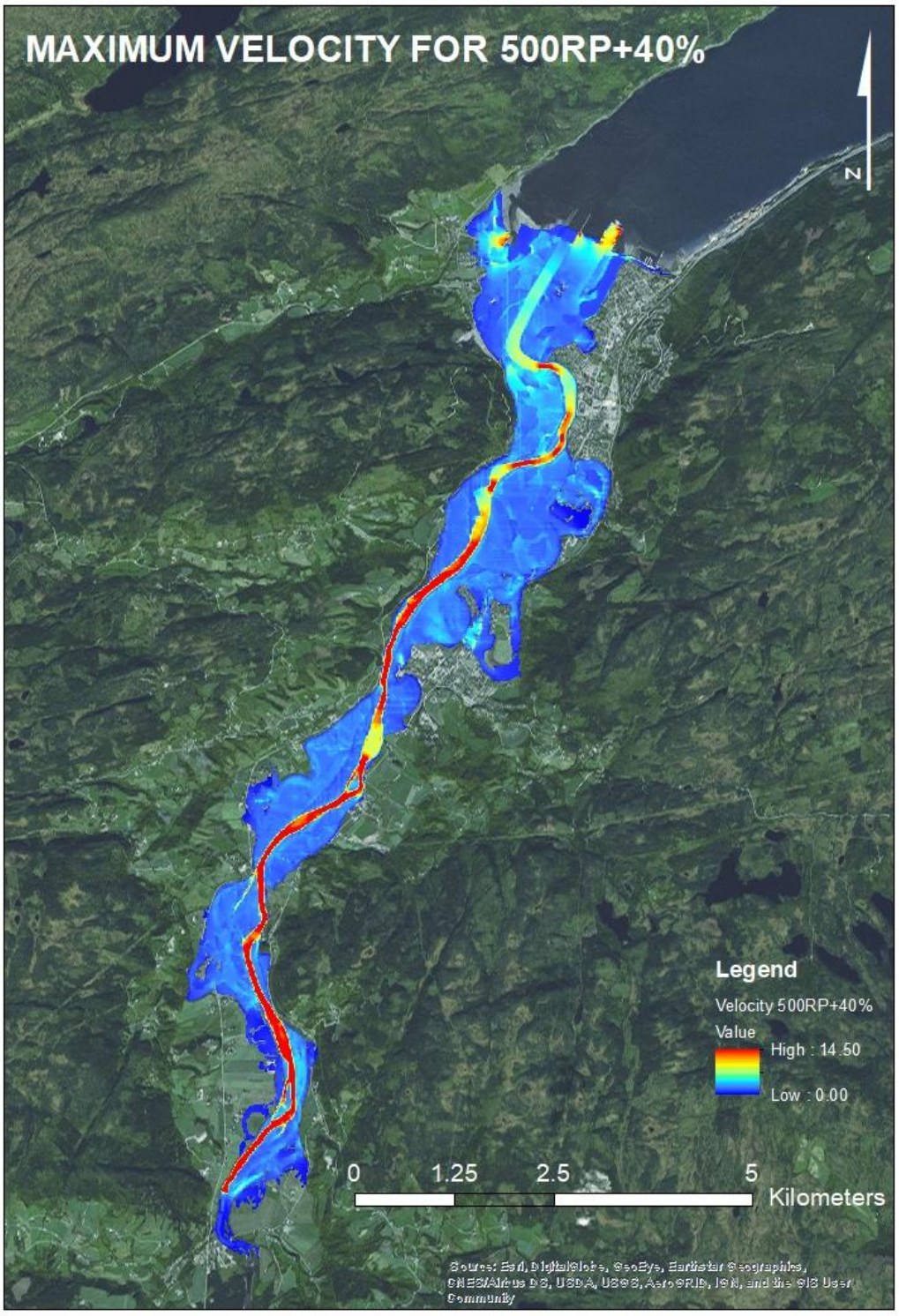

Figure 36: Maximum Velocity for 500 years return period +40%

ANNEX II

Risk model calculations and inputs

In this annex the parameters and inputs applied to the risk model are described.

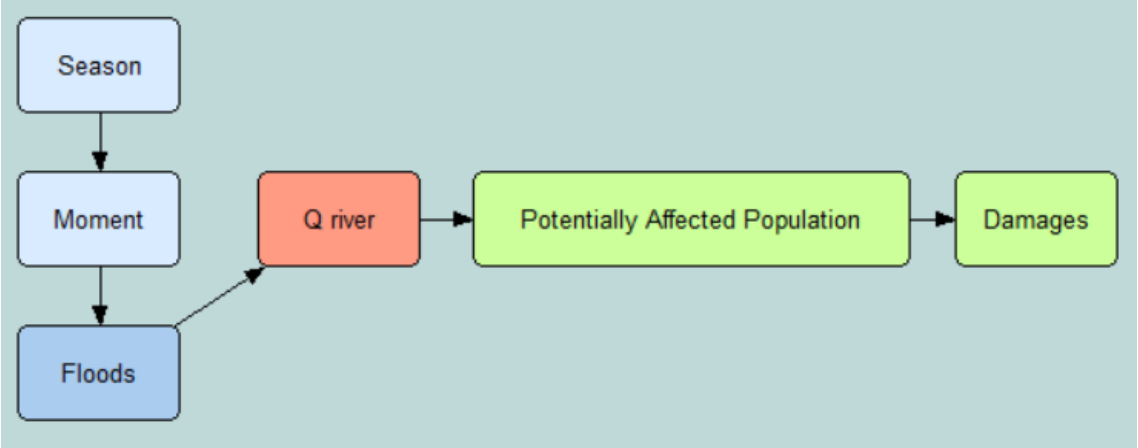

Figure 37: Influence diagram used for the analysis

The model is composed by six nodes, as follows:

For the Season node, it was defined a probability of 50% in each season (summer and winter).

For the moment node, it was assumed a probability of day in summer season of 75% and 25% night. On the other hand, it was defined as the inverse the probability moment for night and day for winter, 75% night and 25% day.

These nodes are used to incorporate into the model the effect of daily or seasonal variation on population at risk. For this case study, population downstream is assumed constant, which means same potentially affected population during the day or at night, and during the year.

For the Floods node includes the minimum and maximum return period. For this case study, the minimum return period was defined as 1 and the maximum as 500.

The Q river node includes the excel sheet file with the flow by return period which is defined in the next table.

Table 1: Input for Q river node defining Qmax for different T in present day

T	AEP	QMax
500	0	2095
100	0	1536
20	0	950
5	0	540
1	1	418

Table 2: Input for Q river node defining Qmax for different T in future case

T	AEP	QMax
500	0	2724
100	0	1997
20	0	1140
5	0	648
1	1	501

The Potentially Affected Population node and the damages were defined by using the flooded areas for different simulations and by the attributes in ArcGis. Then, it was possible to stablish the number of potentially affected buildings by flood and with that, people and economic damage.

Assuming the distribution of potentially affected people follows the same distribution as the following (explained in chapter 4.4 Demography), it is defined the total of affected people.

Table 3: Distribution followed to calculate the number of potentially affected people in flood events

2011						
TOTAL HOUSES	HOUSEHOLD SIZE					TOTAL PEOPLE
	1 PERSON	2 PERSONS	3 PERSONS	4 PERSONS	5 PEOPLE OR MORE	
2224	847	624	303	270	180	4984

Table 4: Count of houses and people potentially affected

RETURN PERIOD	HOUSES AFFECTED	1 PERSON	2 PEOPLE	3 PEOPLE	4 PEOPLE	5 PEOPLE OR MORE	TOTAL PEOPLE AFFECTED
20	238	91	67	32	29	19	533
20+20%	356	136	100	49	43	29	798
100	802	305	225	109	97	65	1797
100+30%	1158	441	325	158	141	94	2595
500	1225	467	344	167	149	99	2745
500+30%	1441	549	404	196	175	117	3229

Table 5: Input for Potentially affected people

QMax	Fatalities
418	0
540	0
950	1206
1536	1797
2095	2745

Table 6: Input for Potentially affected people CC case

QMax	Fatalities
501	0
648	0
1140	1441
1997	2595
2724	3229

Knowing houses affected by the product of depth and velocity more than 2 m^2/s or less as it is explained in chapter 6, it is possible to calculate the economic cost for the different floods calculated in the hydraulic model.

- Flooded buildings (>2m^2/s): 138,341.06 NOK
- Affected buildings (<2m^2/s): 41,423.67 NOK

Table 7:Total cost calculation for different RP and CC Scenarios

	TOTAL ACCOUNT	COUNT < 2m^2/s	COUNT > 2m^2/s	COST < 2m^2/s	COST > 2m^2/s	TOTAL COST (NOK)
RP20	238	193	45	41423.67	138341.06	14220115.84
RP20+20%	356	303	53	41423.67	138341.06	19883447.97
RP100	802	708	94	41423.67	138341.06	42332017.57
RP100+30%	1158	1033	125	41423.67	138341.06	60083283.02
RP500	1225	1048	177	41423.67	138341.06	67898373.04
RP500+30%	1441	1248	193	41423.67	138341.06	78396563.91

With the total cost calculated, it is possible to define the last node.

Table 8: Inputs for Damage node depending on the different flow for each RP and the total cost in NOK (present day)

QMax	Damages
418	0
540	0
950	14220116
1536	42332018
2095	67898373

Table 9: Inputs for Damage node depending on the different flow for each RP and the total cost in NOK

(CC Scenario)

QMax	Damages
501	0
648	0
1140	19883448
1997	60083283
2724	78396564