UNIVERSITÄT DUISBURG ESSEN

Open-Minded

M. Sc. Felix Dacheneder

Institute of Hydraulic Engineering and Water Resource Management

EGU

WaWi UDE

River habitat development – how to assess?

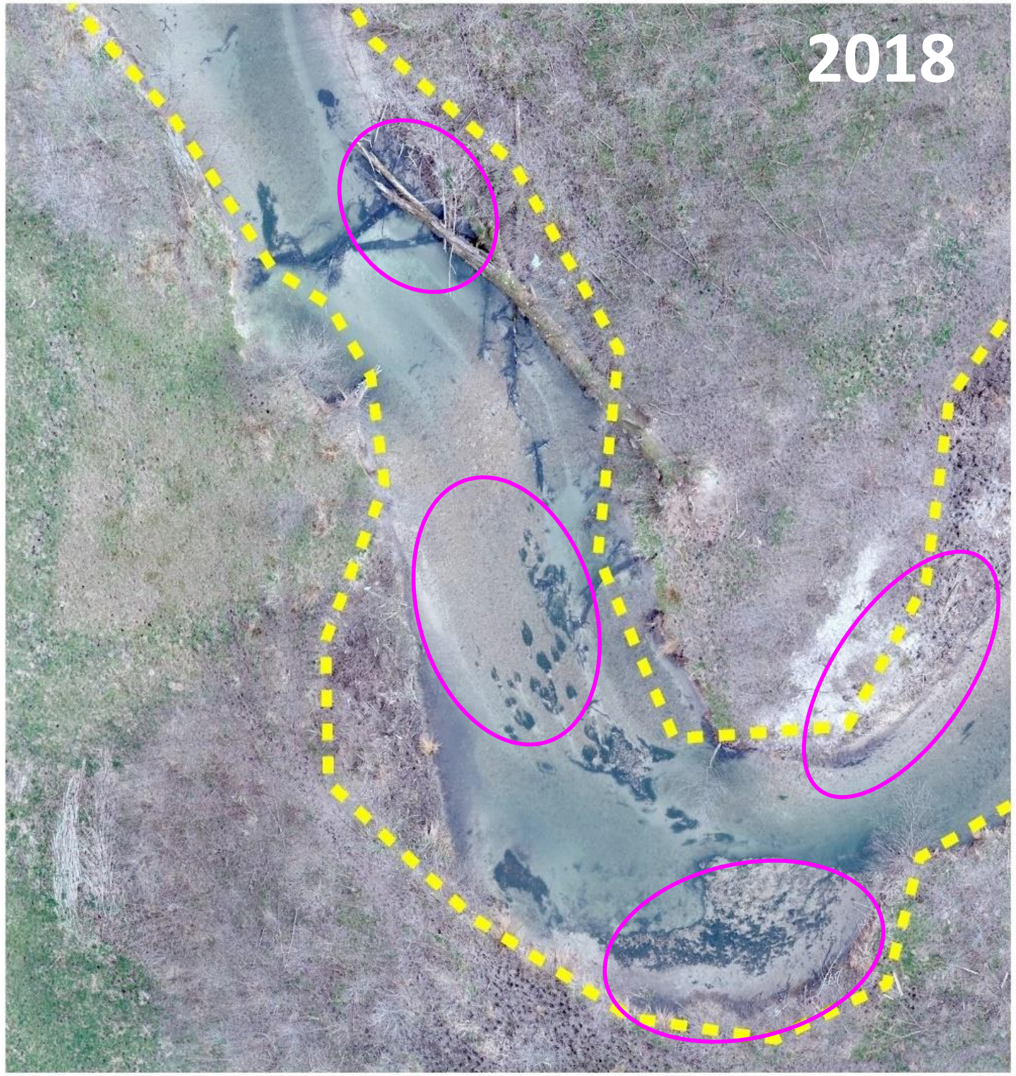
UNIVERSITÄT DUISBURG ESSEN

Open-Minded

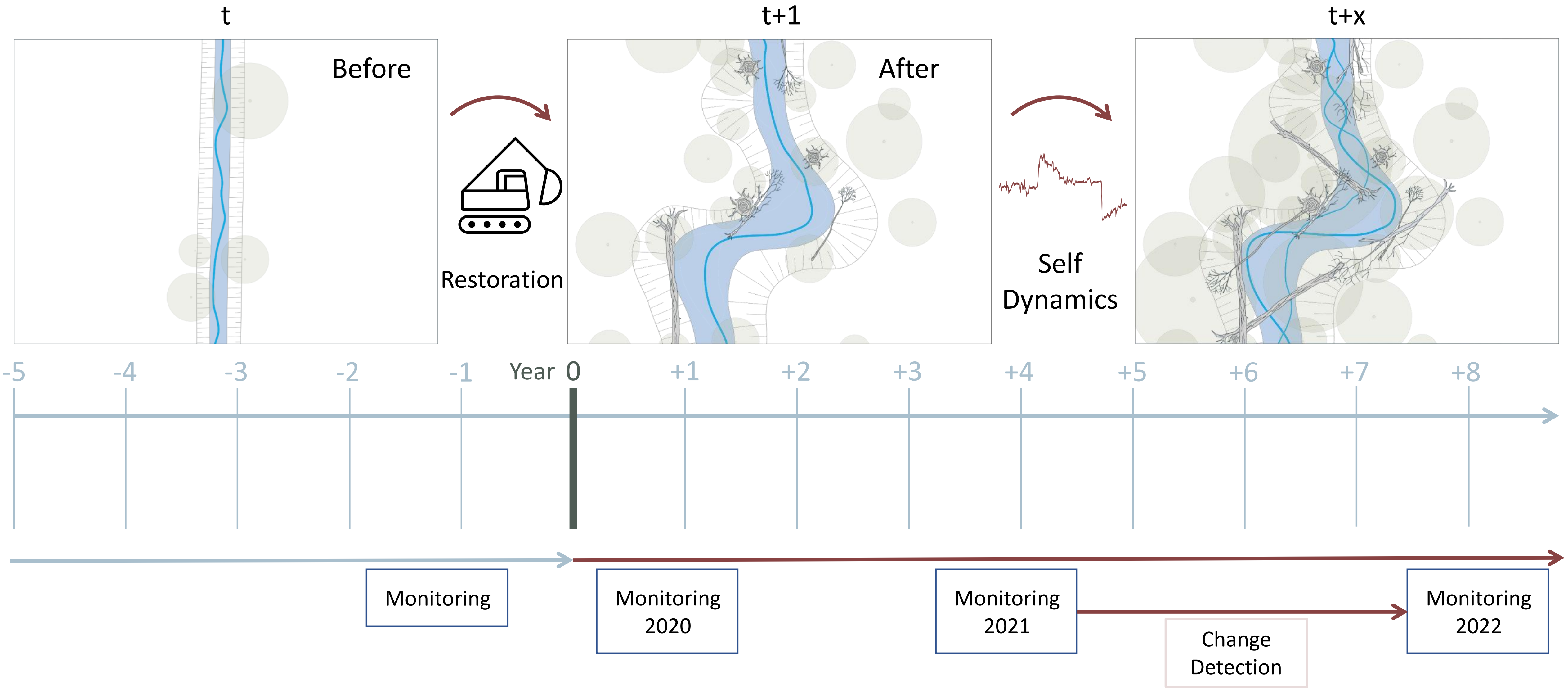
River Lippe

Can river **hydromorphological structures** be quantified?

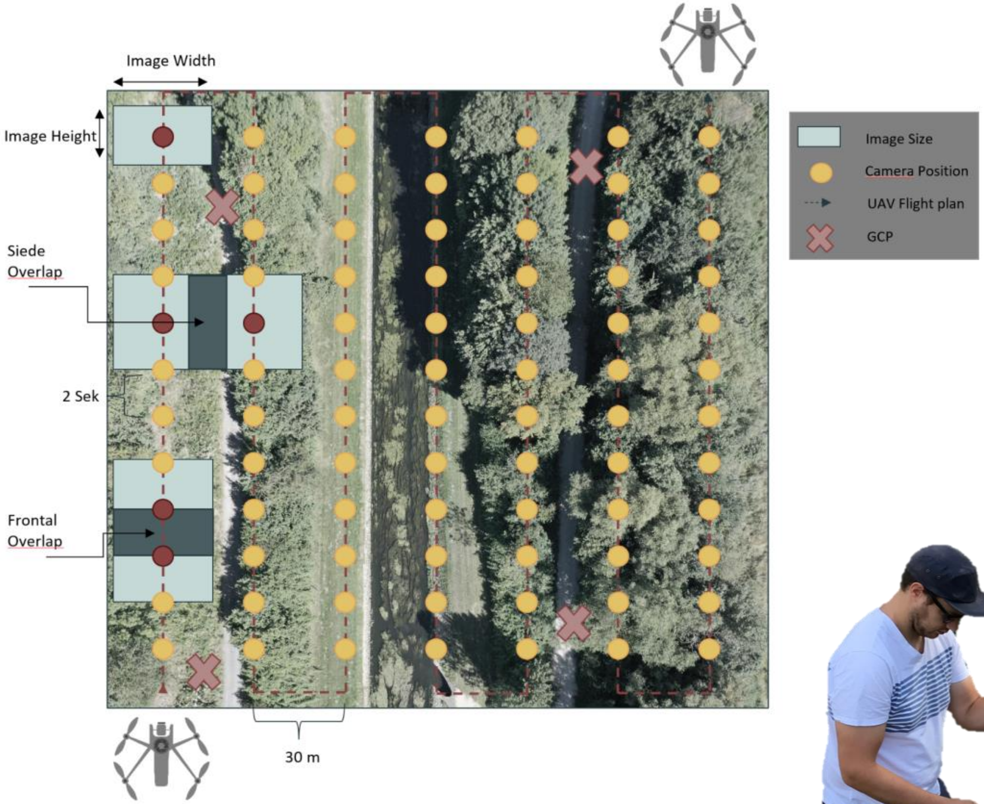
Which **parameters** should be taken into account for quantification?



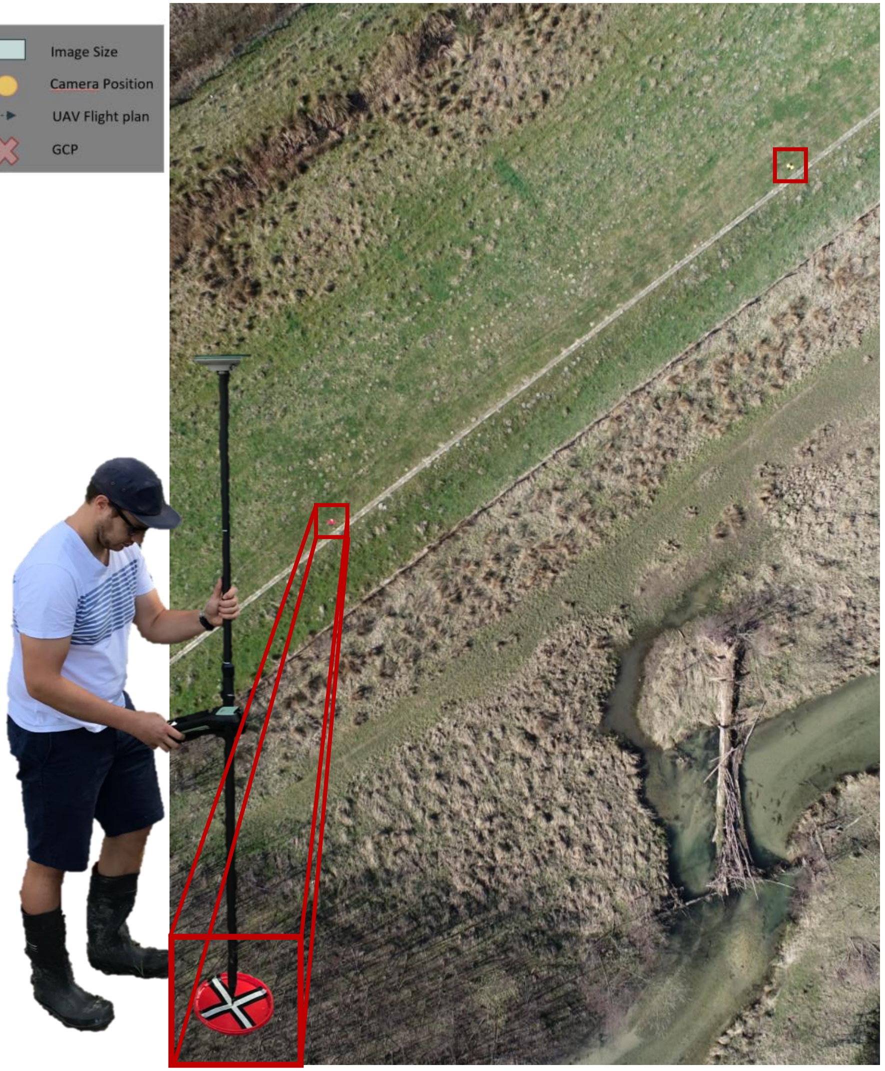
Monitoring Concept



Field survey – Drone & GNSS data acquisition



Date of Survey	Images
20.03.2020	886
17.11.2020	887
16.04.2021	891
25.03.2022	920



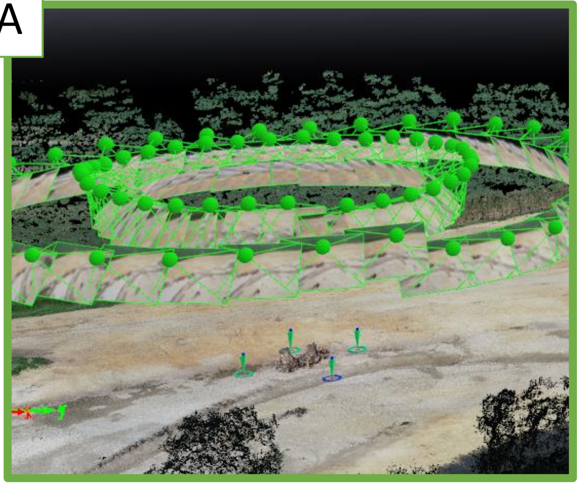
Photogrammetry – The basis for spatial analysis

UNIVERSITÄT DUISBURG ESSEN

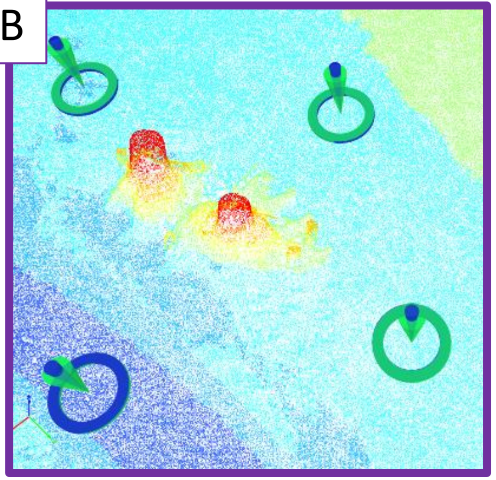
Open-Minded

- Field survey of **drone images, image location and ground control points** [A] to create photogrammetric **3D objects** [B & C]
- 3D objects are generated as **3D point cloud** and 3D **textured** mesh data [C]

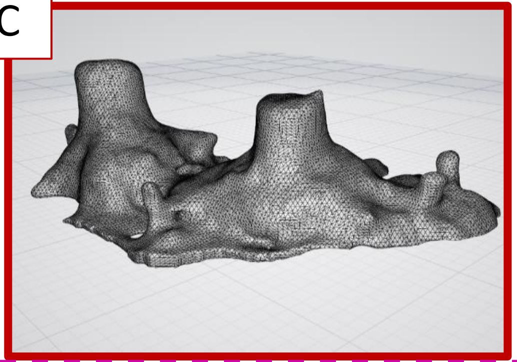
A



B

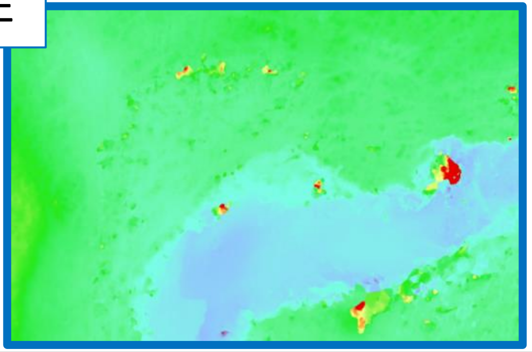


C



D

E

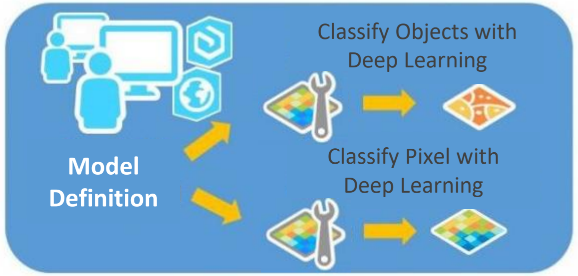


- Based on 3D objects [B & C] high resolution **digital surface model (DSM)** [E] and **orthomosaic** (GSD: 0.8 cm/px) [D] are generated

Pixel classification with AI in ArcGIS Pro

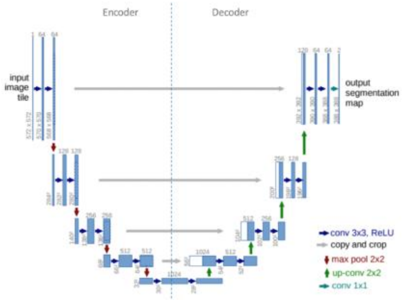
UNIVERSITÄT DUISBURG ESSEN
Open-Minded

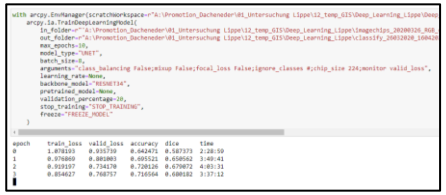
Quelle: esri.de, 2021



Create Training Data
GIS Analysis (GUI)

Built & Train Model
Jupiter Notebook (Python)
Evaluate Model

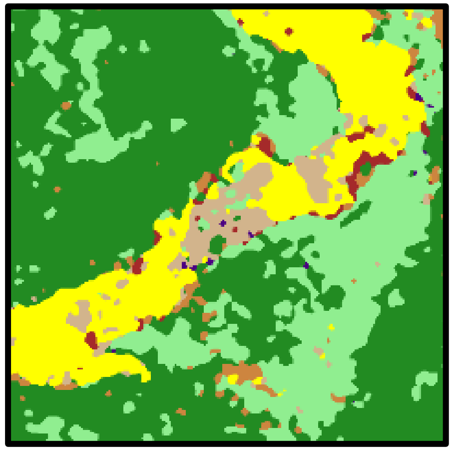




```
with arcpy.EnvManager(scratchWorkspace=r"A:\Promotion_Dacheneder\01_Untersuchung Lippe\12_temp_GIS\Deep_Learning_Lippe\Deep
    arcpy.ia.TrainDeepLearningModel(
        in_folder=r"A:\Promotion_Dacheneder\01_Untersuchung Lippe\12_temp_GIS\Deep_Learning_Lippe\imagechips_20200326_RGB_
        out_folder=r"A:\Promotion_Dacheneder\01_Untersuchung Lippe\12_temp_GIS\Deep_Learning_Lippe\classify_26032020_160420
        max_epochs=10,
        model_type="UNET",
        batch_size=8,
        arguments="class_balancing False;mixup False;focal_loss False;ignore_classes #;chip_size 224;monitor valid_loss",
        learning_rate=None,
        backbone_model="RESNET34",
        pretrained_model=None,
        validation_percentage=20,
        stop_training="STOP_TRAINING",
        freeze="FREEZE_MODEL"
    )
```

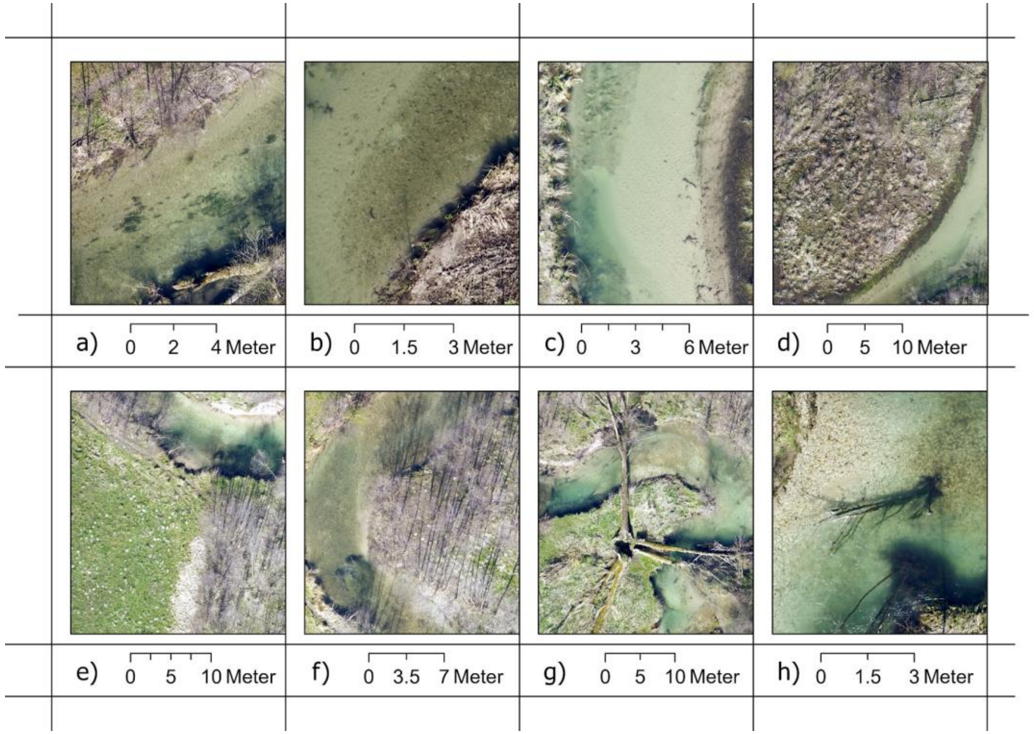
epoch	train_loss	valid_loss	accuracy	dice	time
0	1.078193	0.935739	0.642471	0.587373	2:28:59
1	0.976869	0.801003	0.695521	0.650562	3:49:41
2	0.919197	0.734170	0.720126	0.679072	4:03:31
3	0.854627	0.768757	0.716564	0.680182	3:37:12

Apply Model
GIS Analysis
(GUI & Python)



Classify Pixel

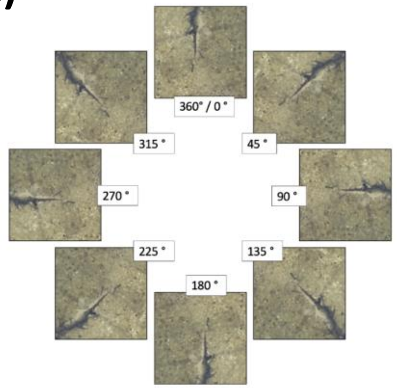
Creating Training data



images = 90307*4*256*256						
features =	90307					
features per image = [min = 1, mean = 1.14, max = 5]						
classes = 7						
Land cover	cls value	images	features	min size	mean size	max size
a) Macrophytes	1	2781	3157	0	1,075	5,465
b) Gravel	2	4817	5357	0	1,875	5,465
c) Sand	3	3144	3613	0	1,395	5,465
d) Gras floodplain	6	14472	14678	0	3,87	5,465
e) Gras	7	28103	29608	0	3,735	5,465
f) Trees	8	29878	30275	0	4,07	5,465
g)+h) Wooden debris	5	3342	3619	0	1,9	5,465

Training Sets (26.03.2020, 16.04.2021)

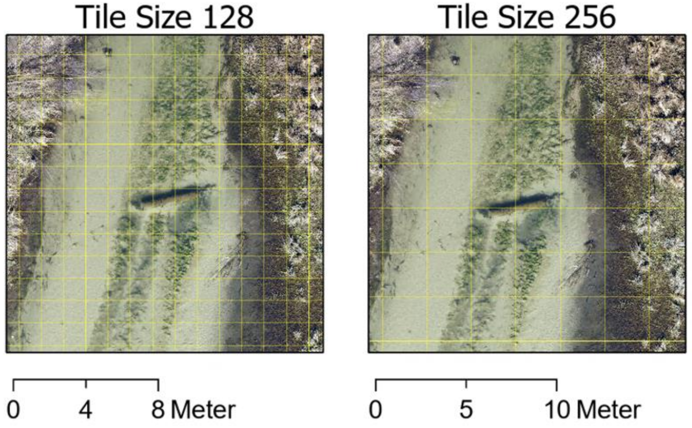
- Rotation (0)



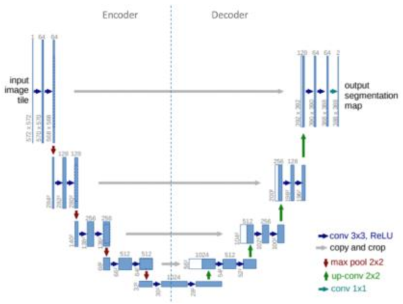
Quelle: esri.de, 2021

- Stride (128)

- Tile Size (256)



Training & Evaluation Deeplearning Model

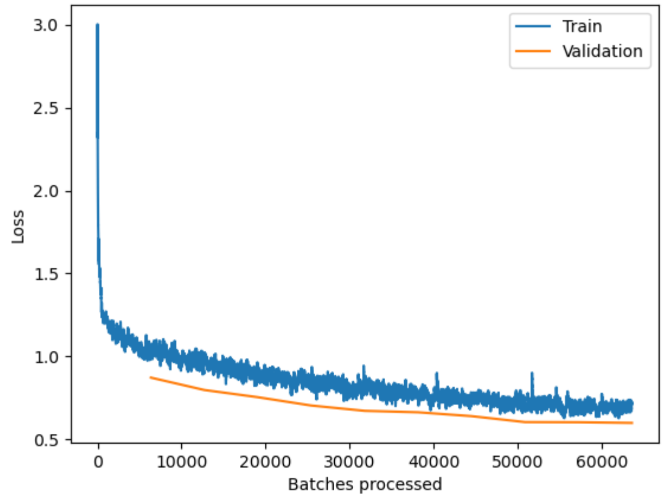


Parameter of Trainingdata	
Bands	RGB
Tile Size and Stride	256/128
Rotation	0

Model Setup	
Model Type	U-Net
Validation	20%
Backbone Model	ResNet-34
Epochs	10

```
with arcpy.EnvManager(scratchWorkspace=r"A:\Promotion_Dacheneder\01_Untersuchung Lippe\12_temp_GIS\Deep_Learning_Lippe\Deep_
    arcpy.ia.TrainDeepLearningModel(
        in_folder=r"'A:\Promotion_Dacheneder\01_Untersuchung Lippe\12_temp_GIS\Deep_Learning_Lippe\imagechips_20200326_RGB_
        out_folder=r"A:\Promotion_Dacheneder\01_Untersuchung Lippe\12_temp_GIS\Deep_Learning_Lippe\classify_26032020_160420
        max_epochs=10,
        model_type="UNET",
        batch_size=8,
        arguments="class_balancing False;mixup False;focal_loss False;ignore_classes #;chip_size 224;monitor valid_loss",
        learning_rate=None,
        backbone_model="RESNET34",
        pretrained_model=None,
        validation_percentage=20,
        stop_training="STOP_TRAINING",
        freeze="FREEZE_MODEL"
    )
```

epoch	train_loss	valid_loss	accuracy	dice	time
0	1.078193	0.935739	0.642471	0.587373	2:28:59
1	0.976869	0.801003	0.695521	0.650562	3:49:41
2	0.919197	0.734170	0.720126	0.679072	4:03:31
3	0.854627	0.768757	0.716564	0.680182	3:37:12



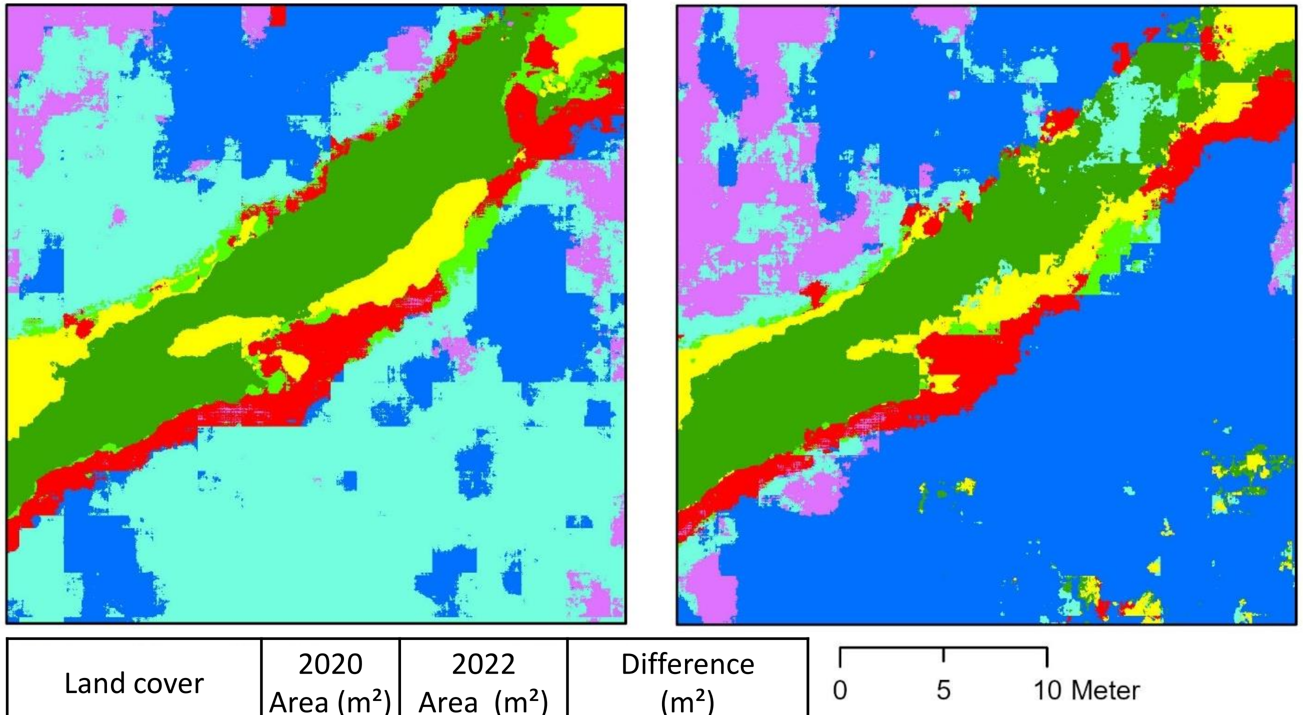
	NoData	Macrophytes	Gravel	Sand	Wooden debris	Gras Floodplain	Gras	Trees
precision	0,73	0,70	0,70	0,70	0,73	0,79	0,75	0,82
recall	0,49	0,31	0,71	0,69	0,45	0,76	0,95	0,92
f1	0,59	0,43	0,71	0,70	0,55	0,78	0,84	0,87

Apply Deeplearning Model for Pixel Classification

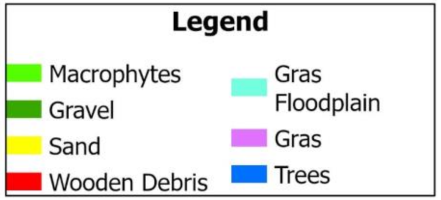
UNIVERSITÄT DUISBURG ESSEN

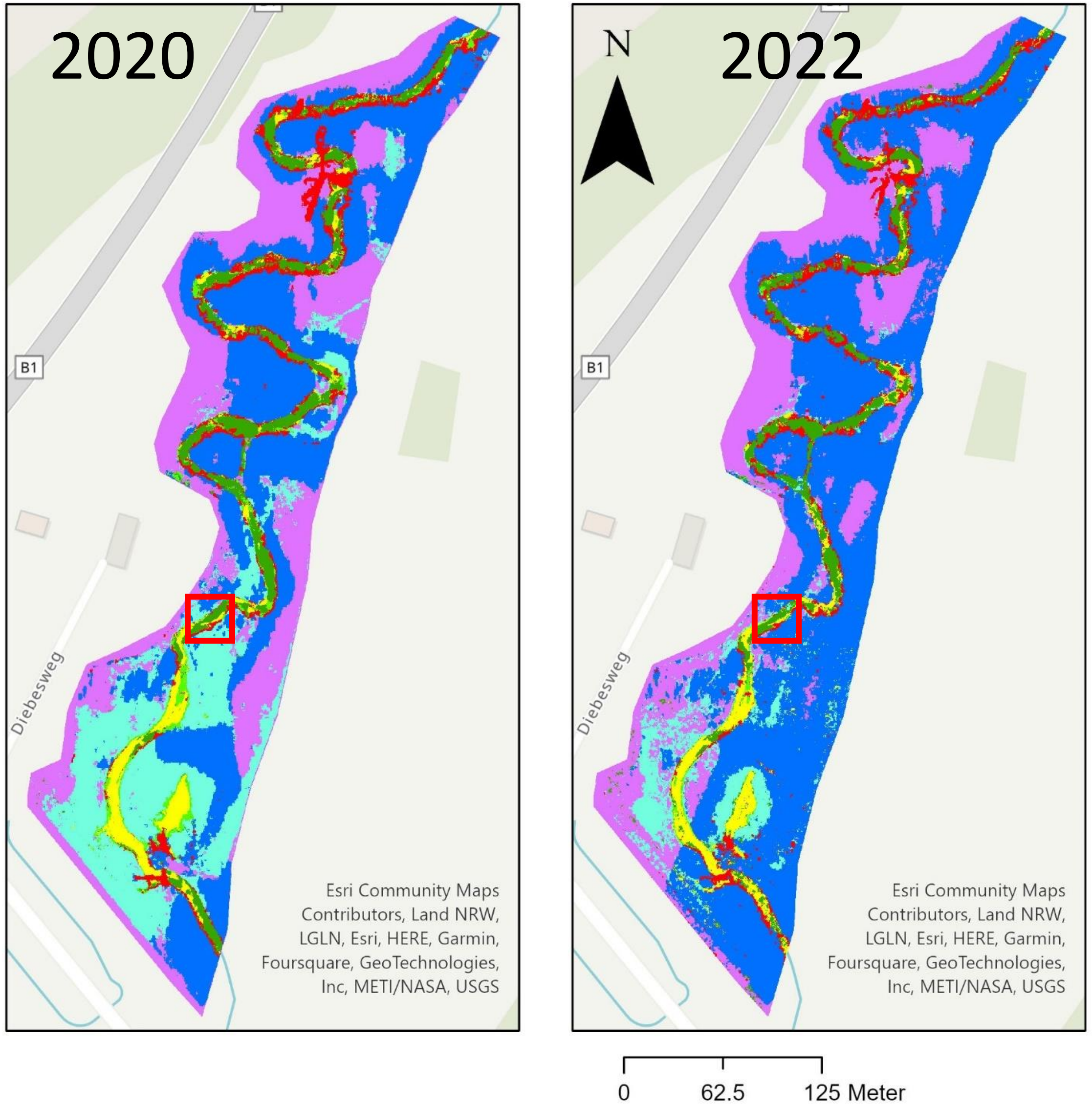
Open-Minded

2020 2022



Land cover	2020 Area (m²)	2022 Area (m²)	Difference (m²)
Macrophytes	1191	507	-684
Gravel	2994	3431	437
Sand	1663	2170	507
Wooden Debris	2776	3360	584
Gras Floodplain	10061	4234	-5827
Gras	13607	15681	2074
Trees	17780	32022	14242

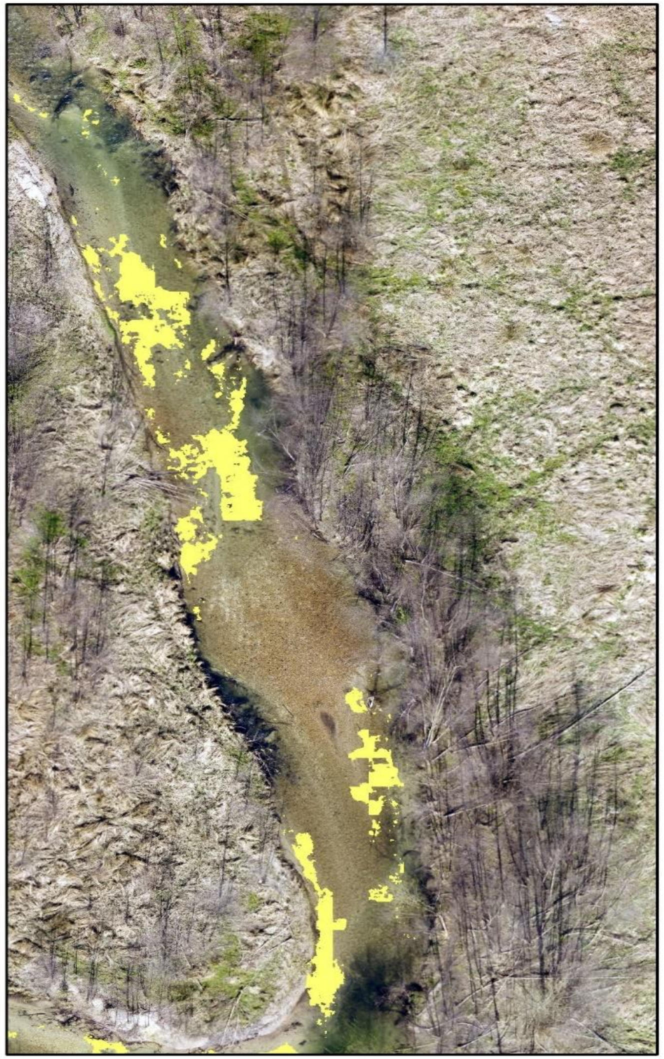




Change detection 2020 to 2022

Land cover	Area m²
Macrophytes->Gravel	207
Macrophytes->Sand	194
Macrophytes->Wooden Debris	332
Gravel->Macrophytes	48
Gravel->Sand	**366**
Gravel->Wooden Debris	481
Sand->Macrophytes	112
Sand->Gravel	**207**
Sand->Wooden Debris	167
Wooden Debris->Macrophytes	66
Wooden Debris->Gravel	302
Wooden Debris->Sand	131
Other	52858
No Change	5945

Legend
- Sand->Gravel
- Gravel->Sand



Thank you!

Felix Dacheneder, M.Sc.

Institute of Hydraulic Engineering and Water Resource Management
University of Duisburg-Essen

Felix.dacheneder@uni-due.de