

LTER-LIFE

Where you build digital twins of ecosystems

4-nov-2025

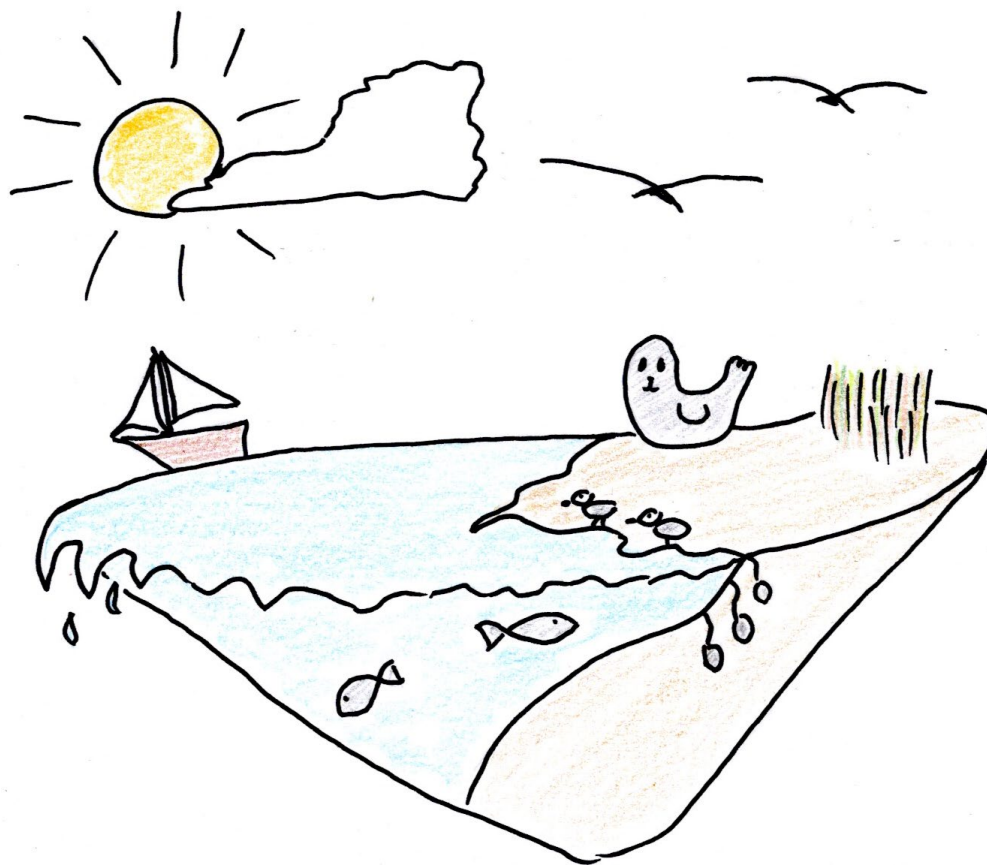
Geerten Hengeveld

g.Hengeveld@nioo.knaw.nl

Wadden datadag 2025



Leaning heavily on all the work within the LTER-LIFE consortium especially
Stefan Vriend, Cherine Jantzen, Qing Zhan, Stanley Nmor



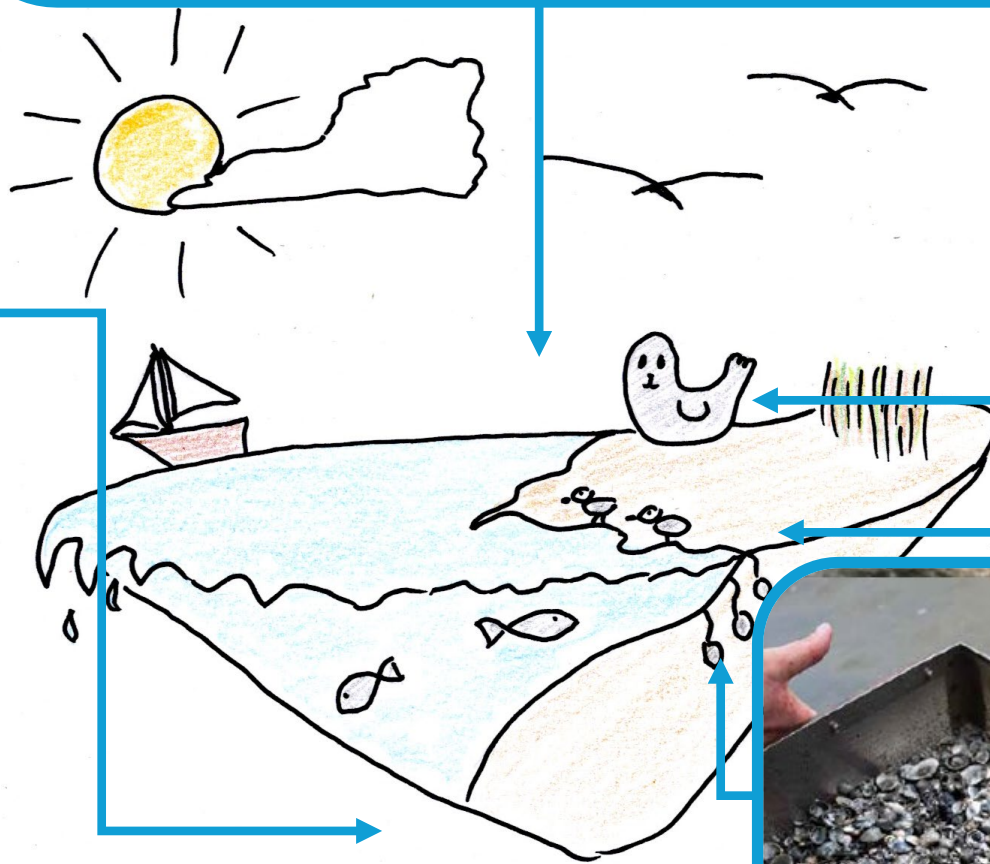
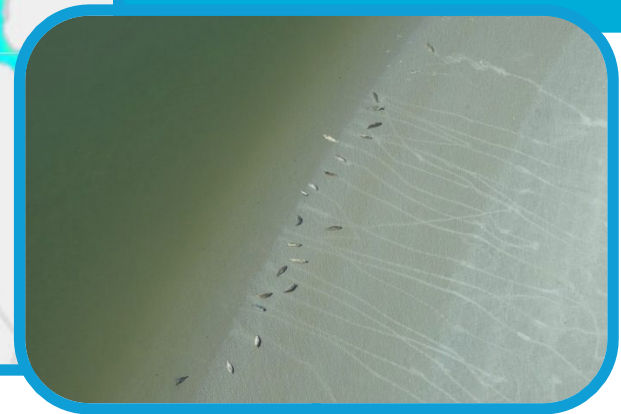


Illustration: Geerten Hengeveld
Photos:
Hannes Grobe (Boxcore),
Benjamin Gep (Knot)
Jan Smit, NIOZ (others)

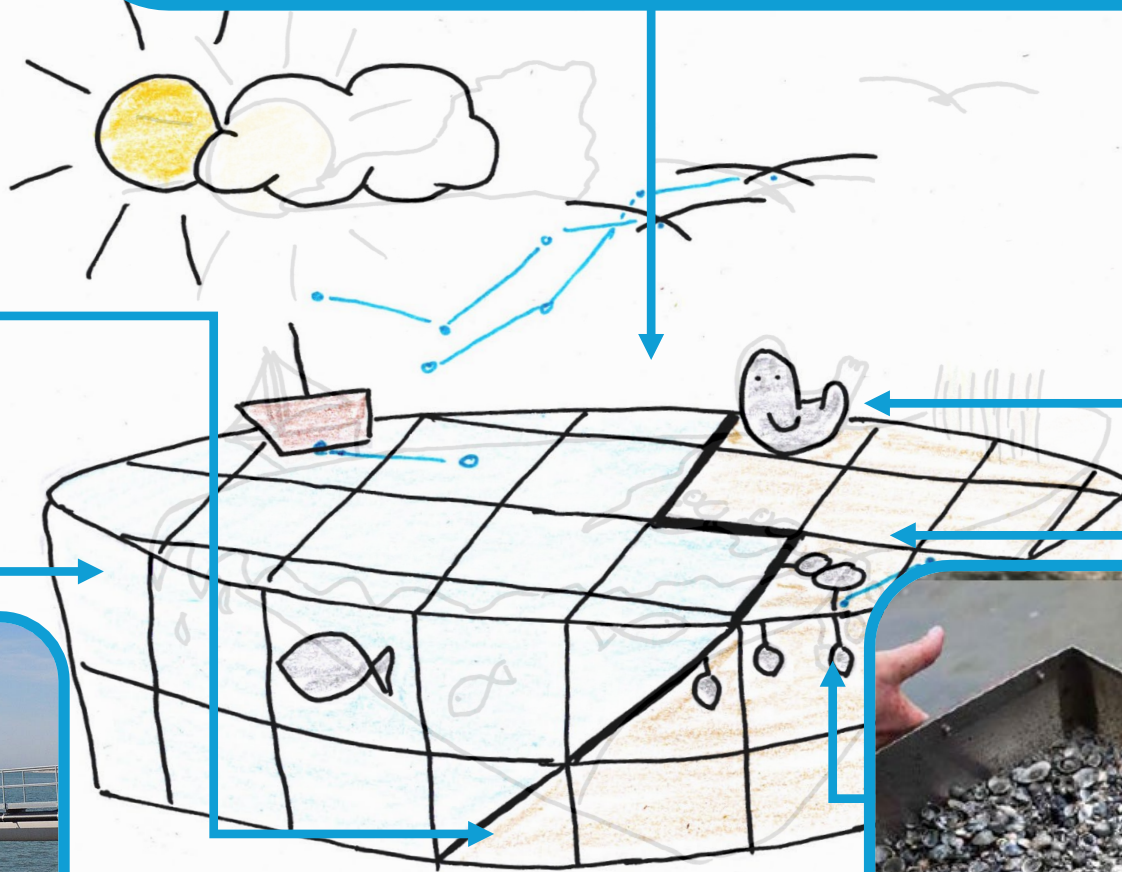
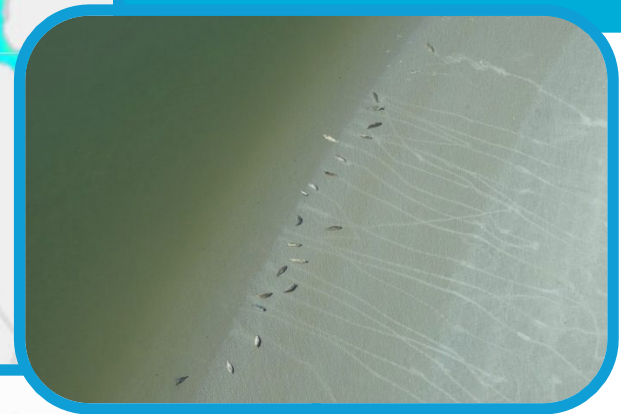
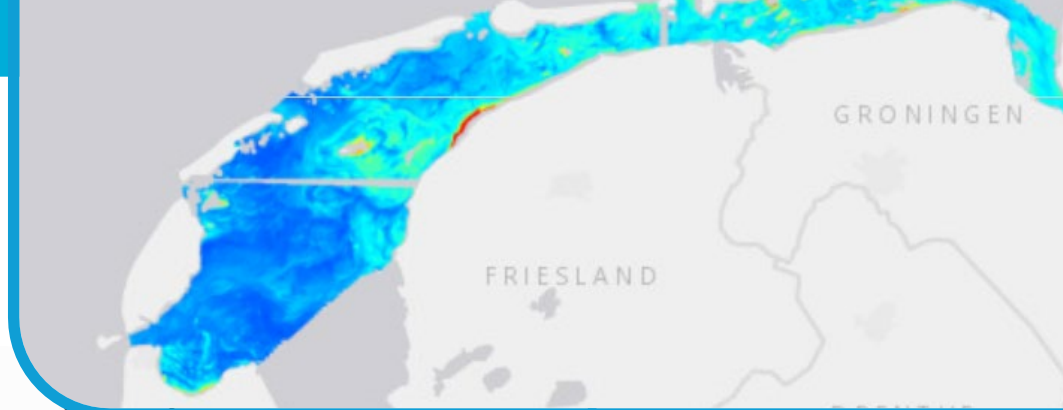


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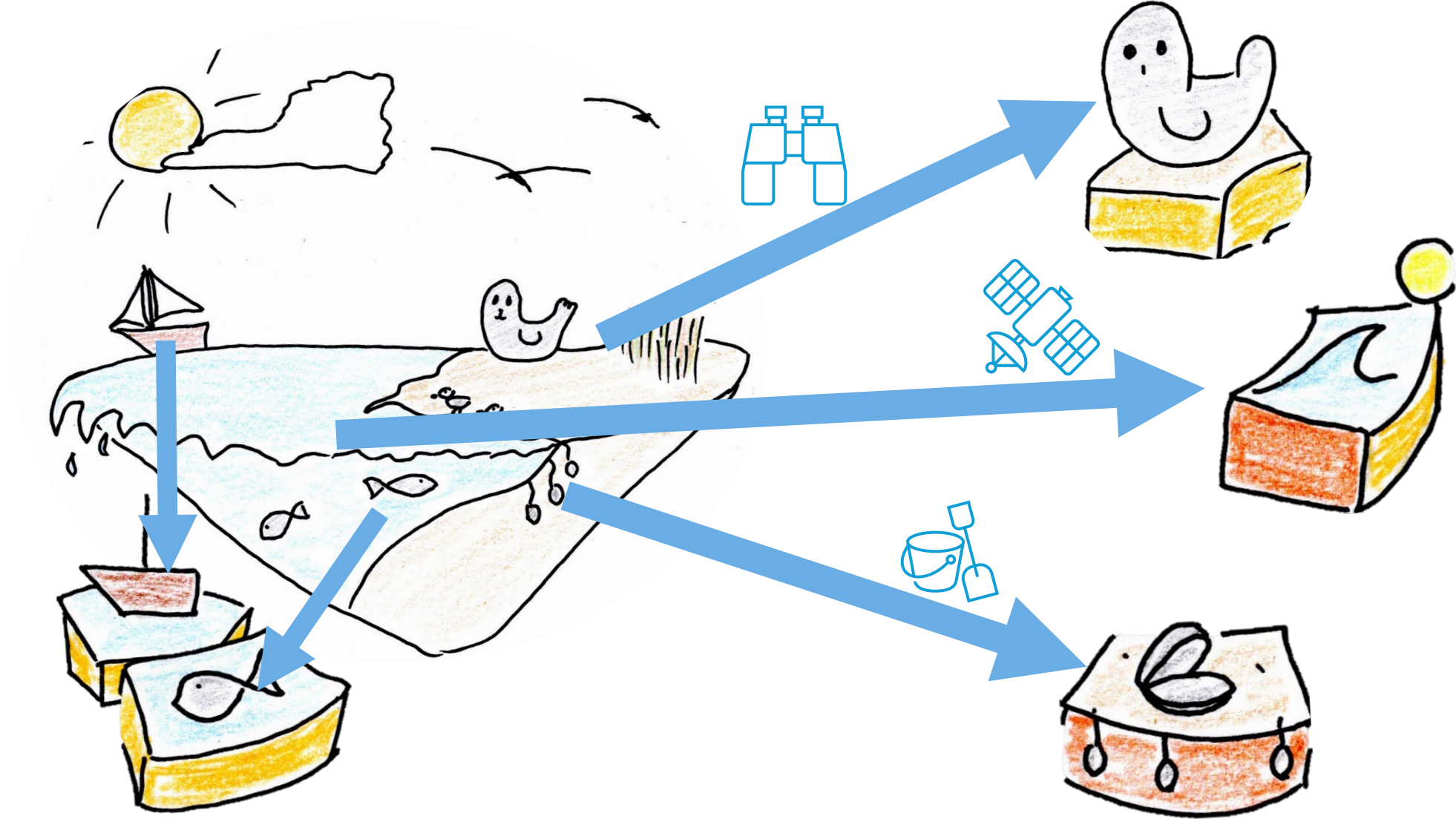


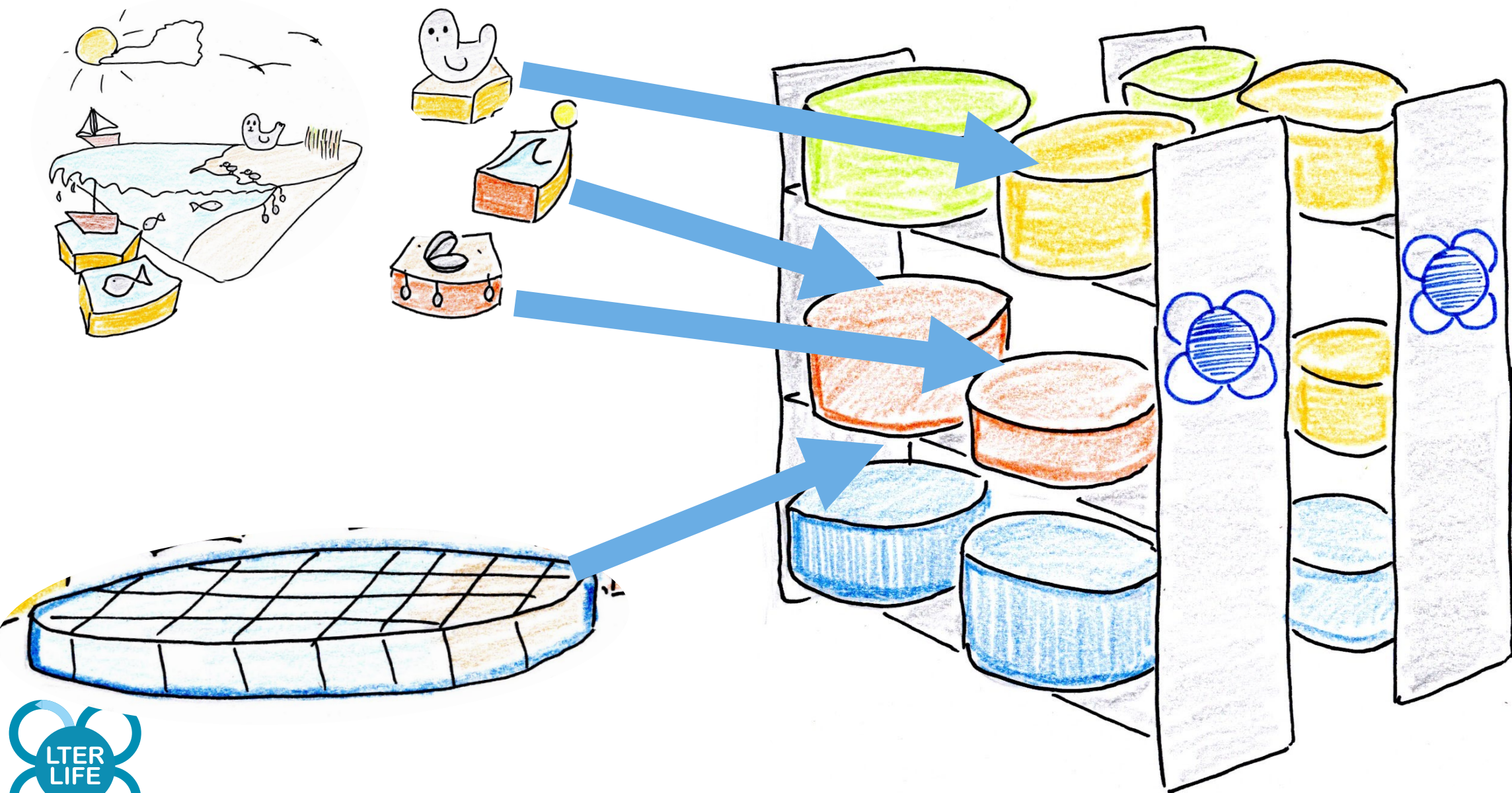
Main elements of a Digital twin

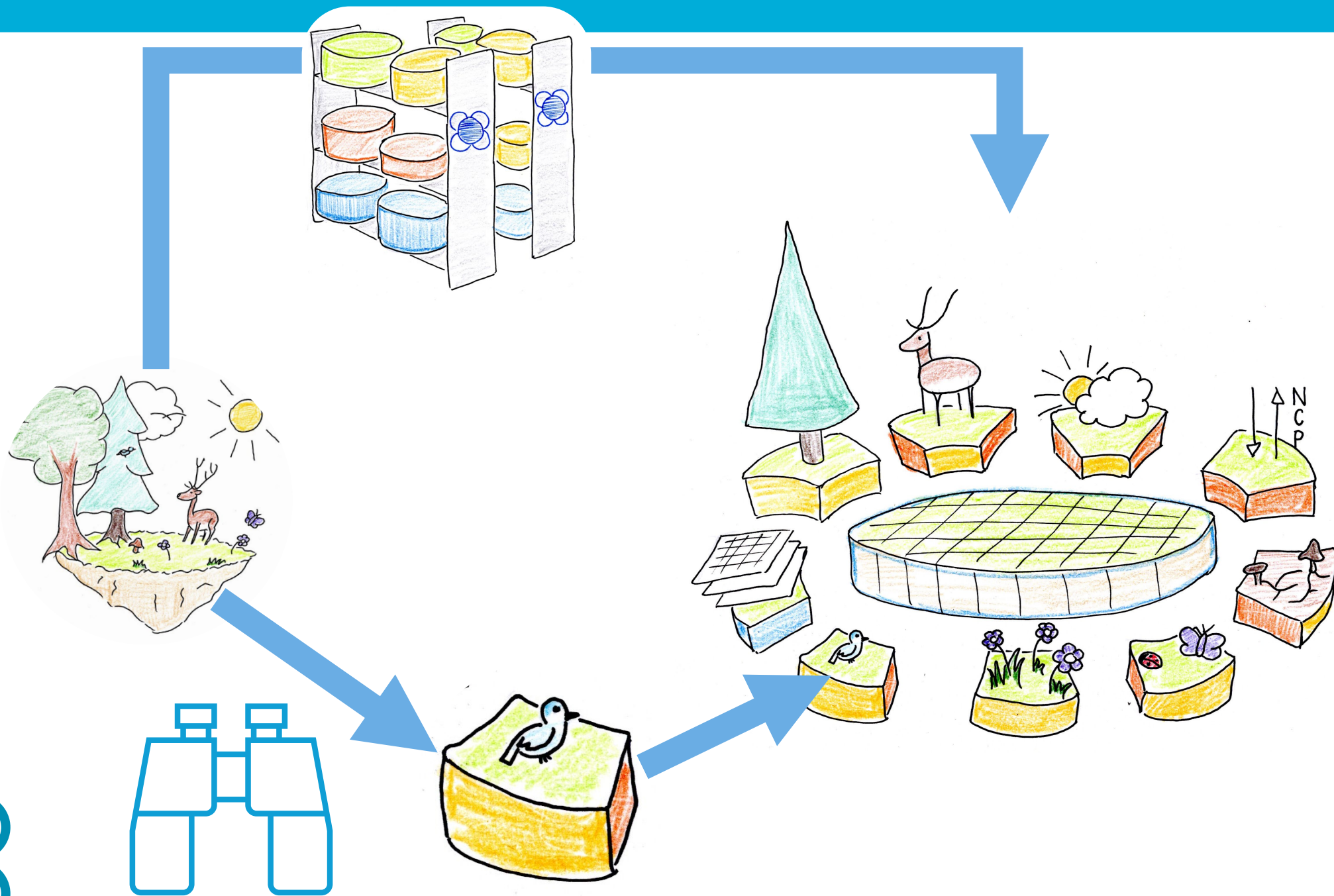
In ecology
according to Geerten

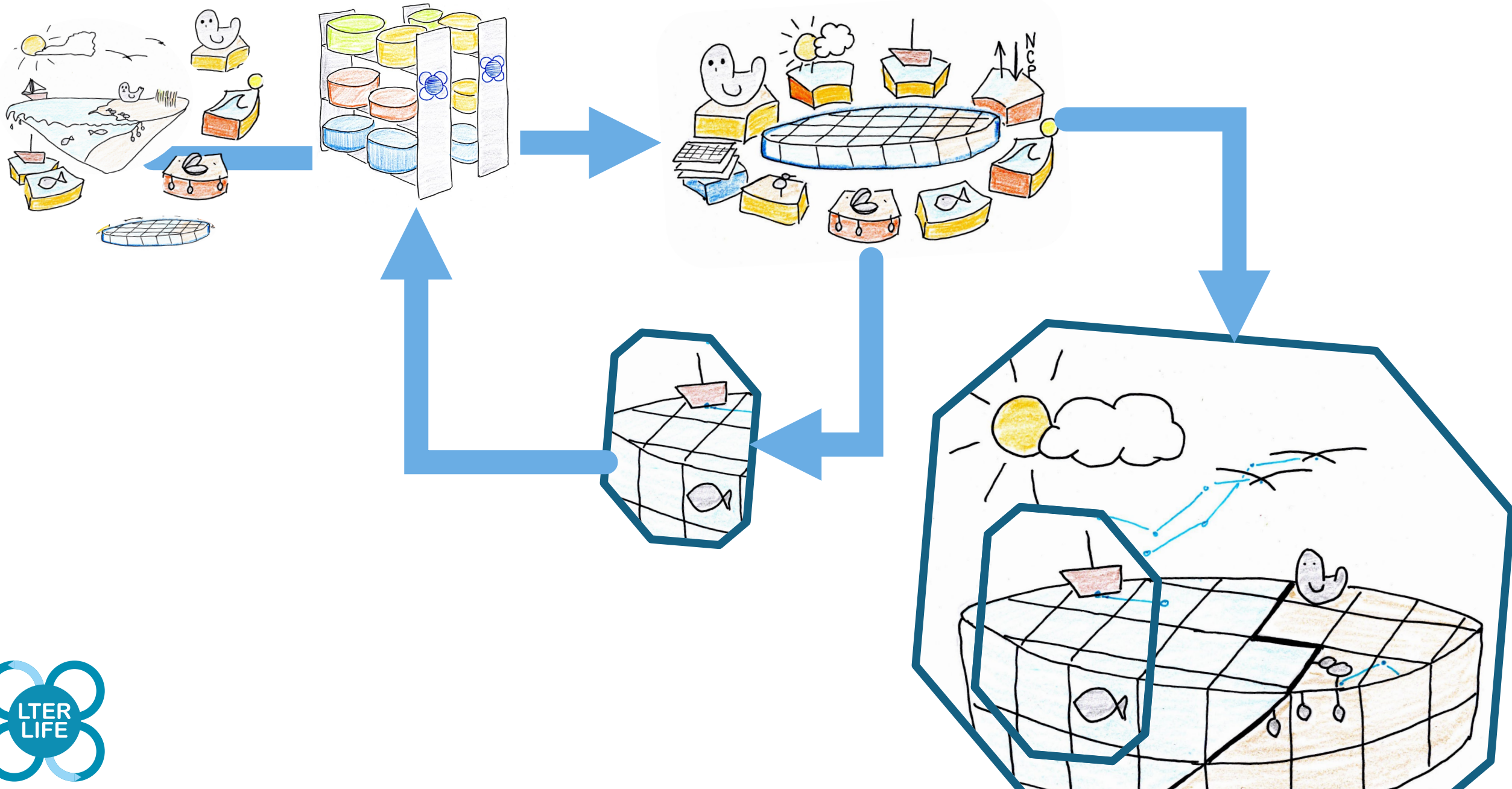
- Best estimate
 - Integrating 'all' data, models & knowledge
 - Using the tools that we have
-
- Specific location
 - Continuous in space & time & variables
 - Tailored to application

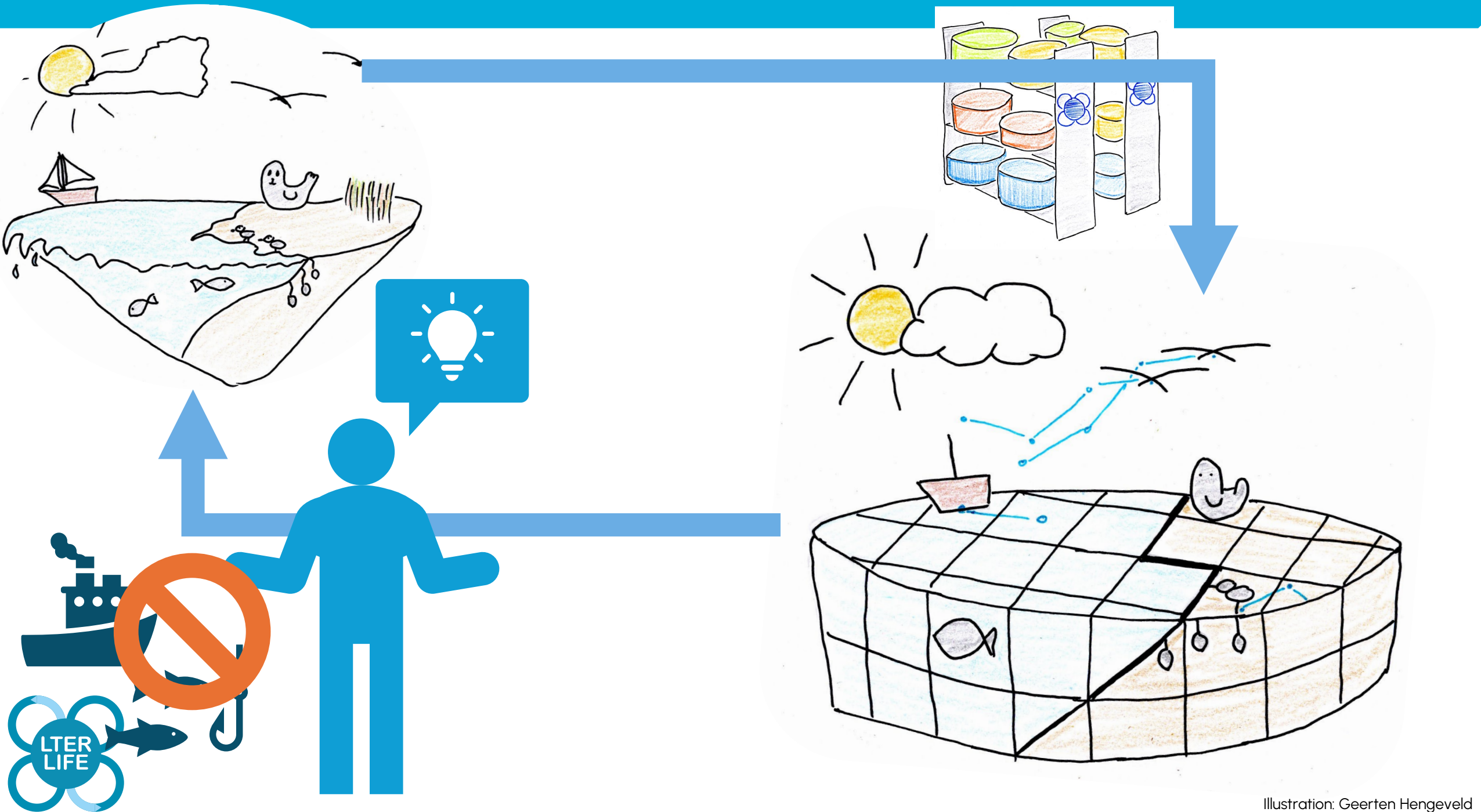


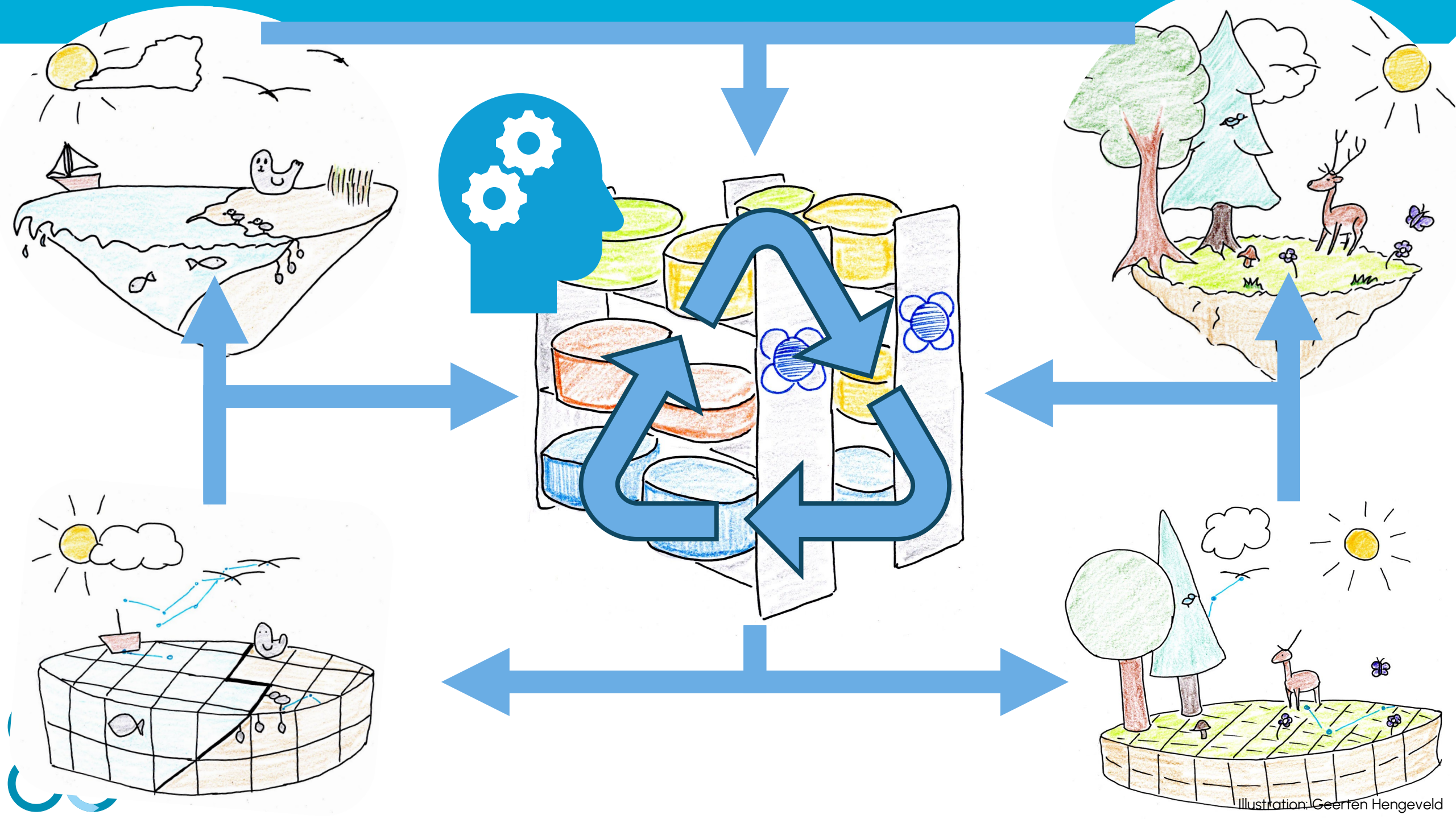












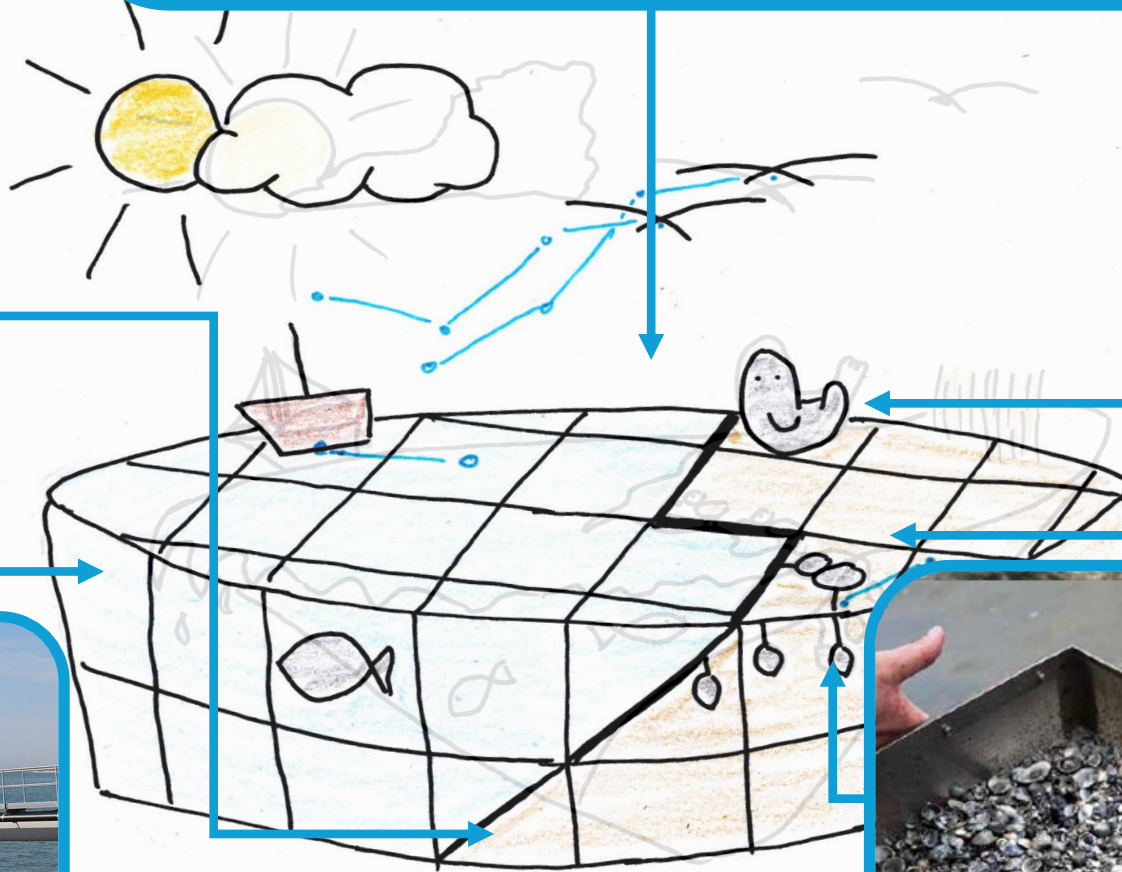
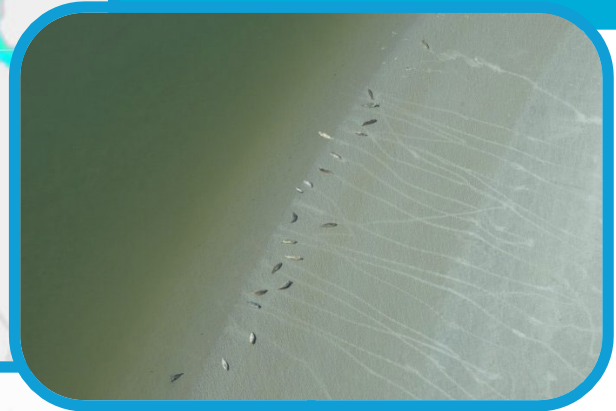
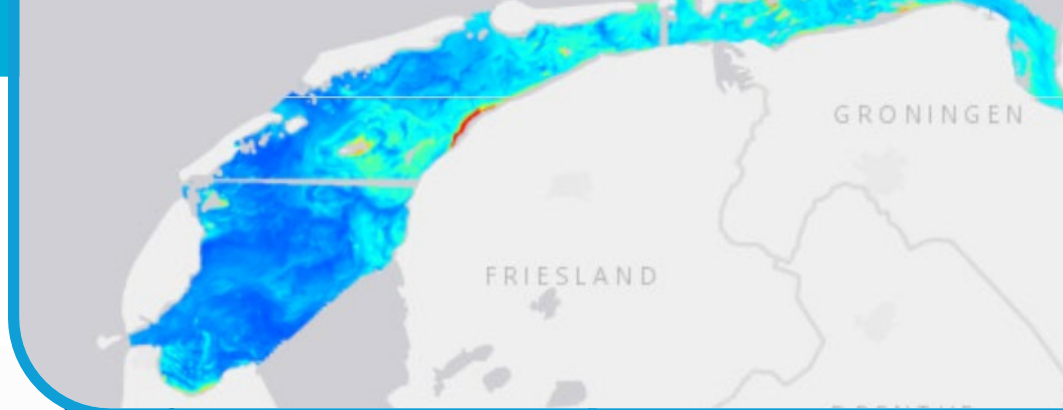
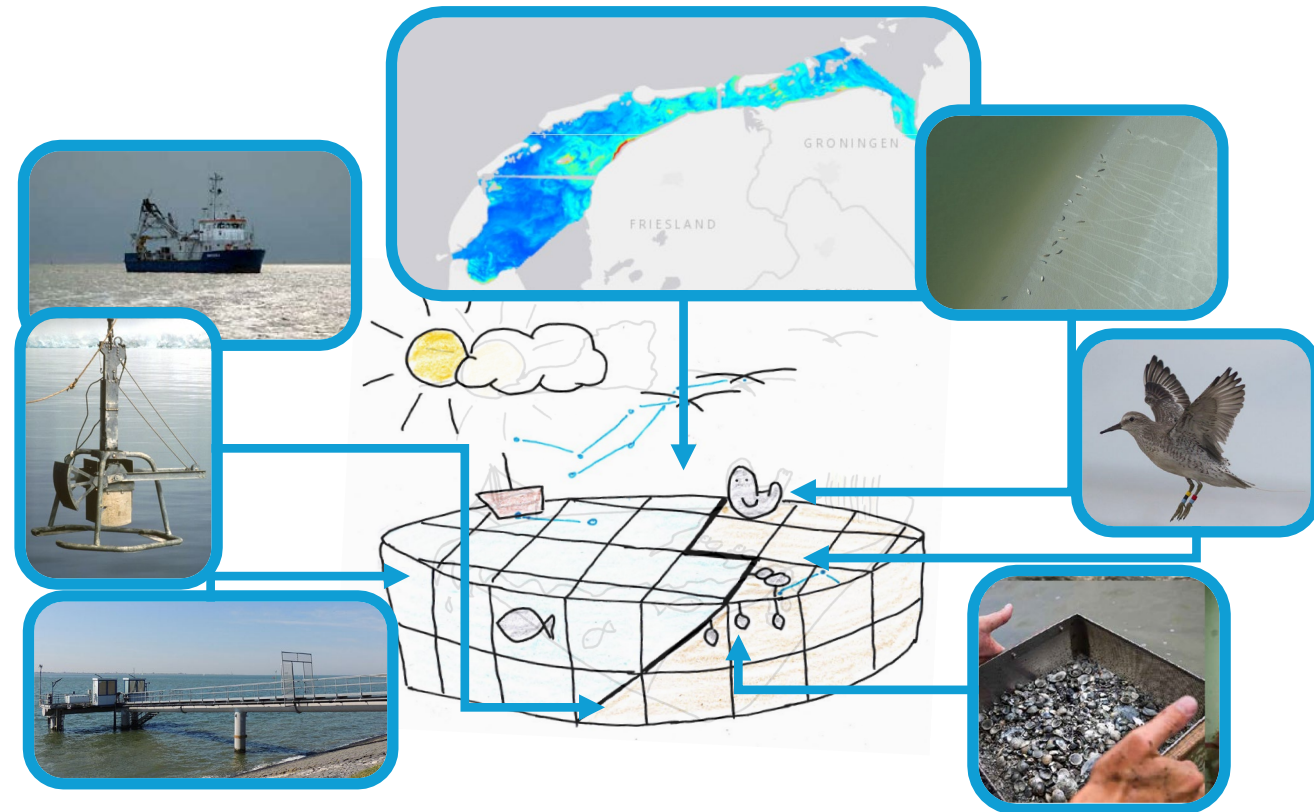


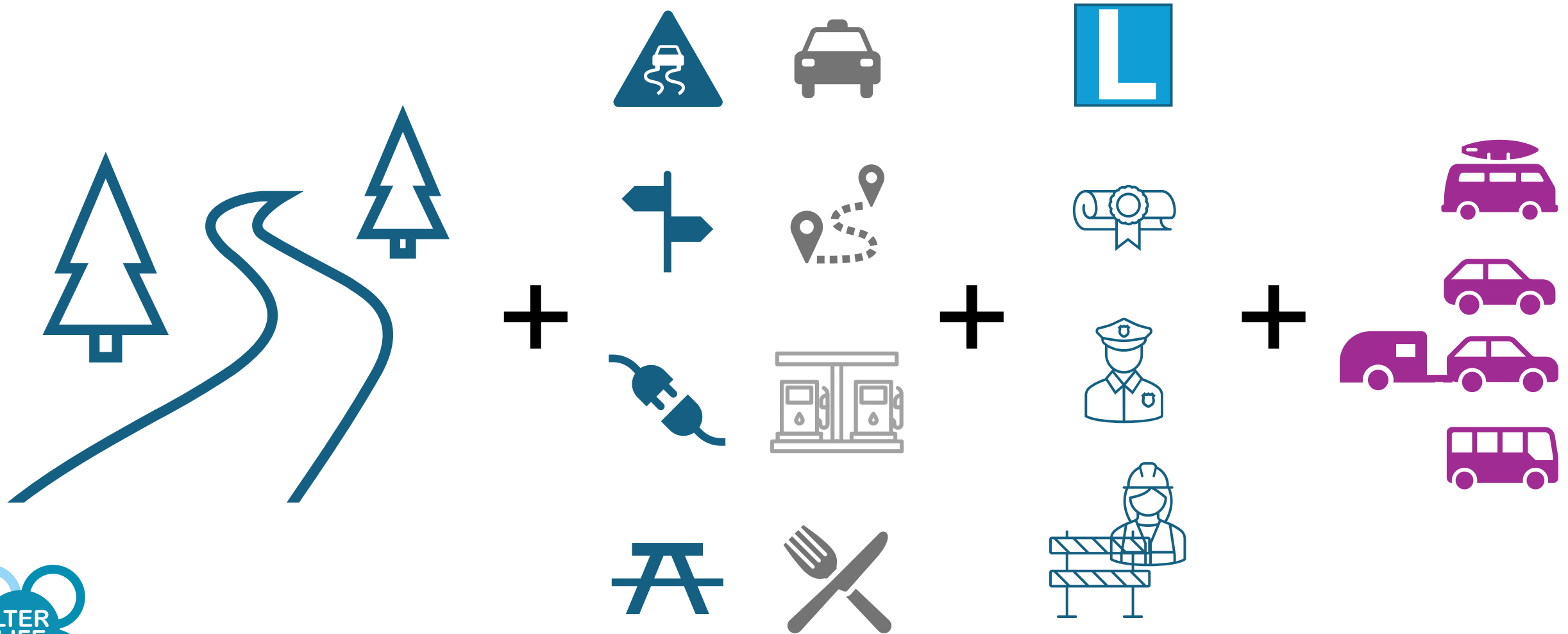
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This is an invitation

- Share (research) results
 - FAIR and OPEN science
- Re-use results of others
- Connect
- Discuss
 - technical standards
 - metadata
 - ecology
- Work together!
-



Research Infrastructure



Three types of service

Expertise & Stewardship



VRE & Tools



Education & Training



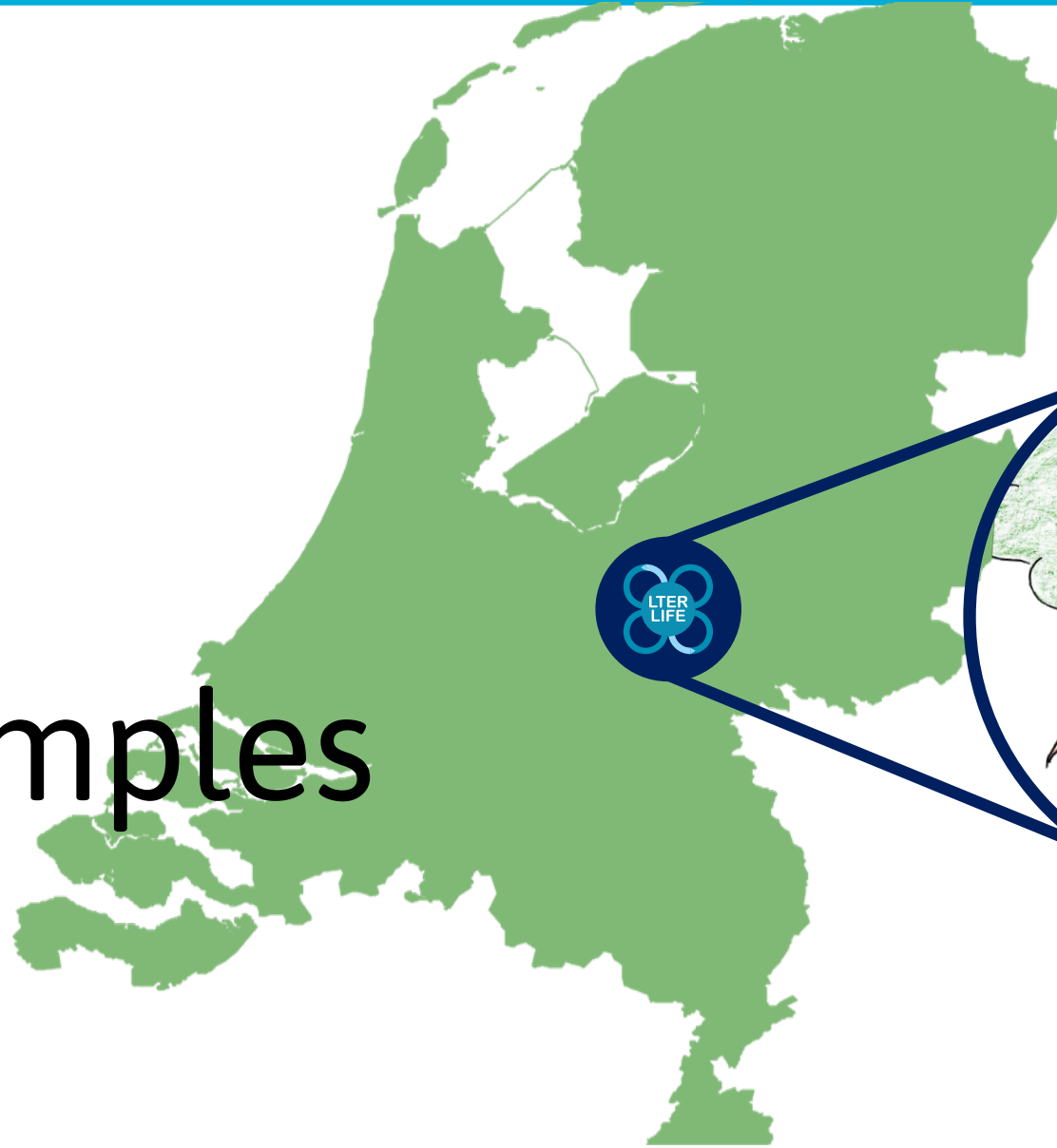
LTER-LIFE cycle *for digital twinning*

- Four fields of focus
- Community & Research are at the core of what we do



Some examples

Veluwe





Lily

organisation

NIOO-KNAW

job

data manager

background

ecology

role:
FAIR data analyst

I want to **make long-term dataset on oak phenology FAIR**

so that the **data can be made available in the LTER-LIFE asset library and reused by others.**



Mary

organisation

RuG

job

PhD student

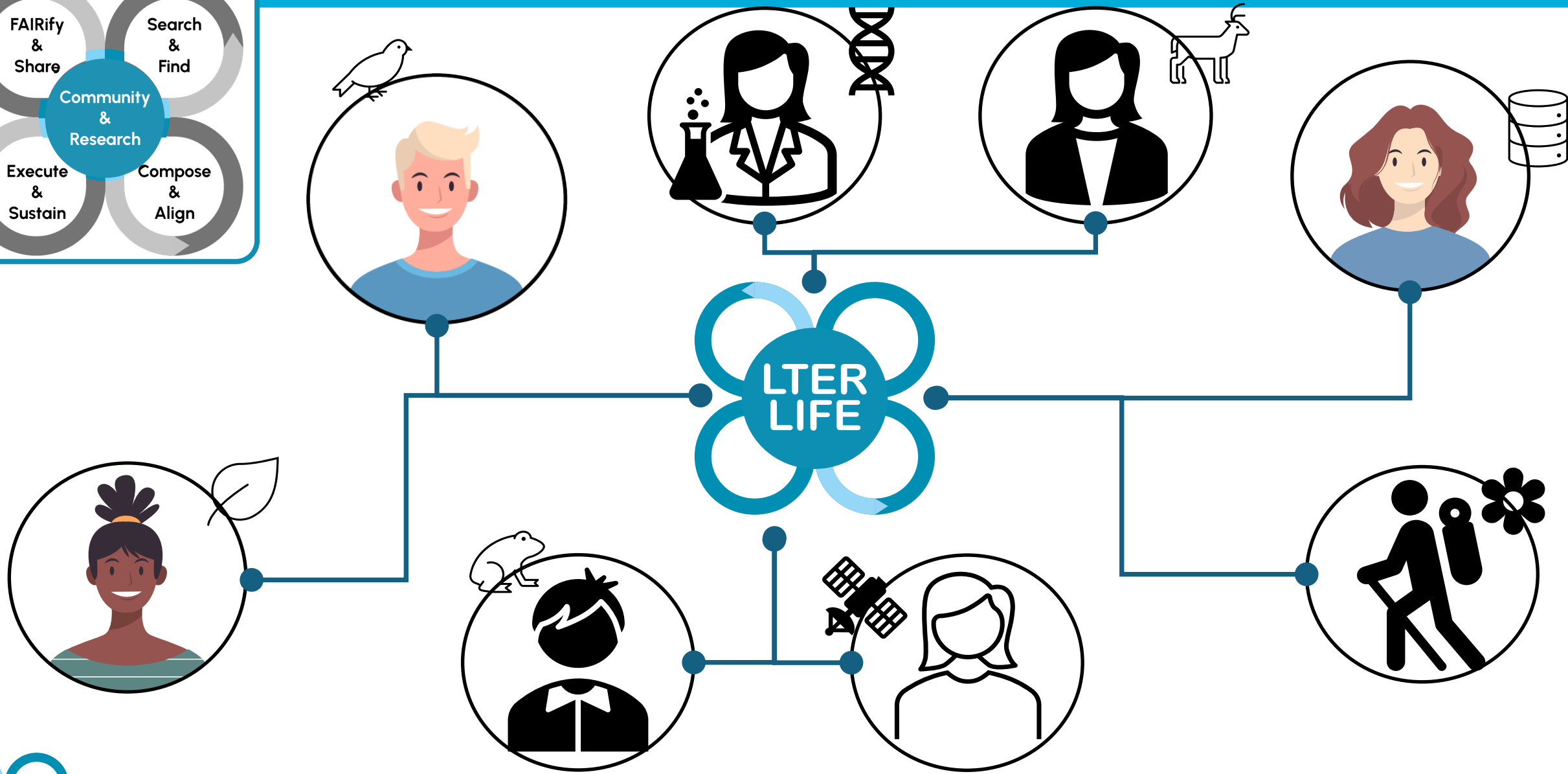
background

conservation
biology

role:
Ecological researcher

I want to **couple data and models to analyse the timing of tree leaf unfolding**

so that I can **understand how climate change will affect the phenology of oak in the future.**





Chapter 2

FAIR assessment

How FAIR is your data now? How FAIR can yo

Storage



Standard



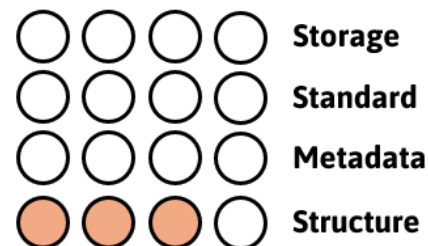
Metadata



Structure



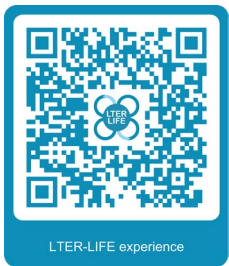
FAIRness of
your data



How to improve the FAIRness of your data?

Go through the following steps:

- **Create metadata**
see chapter 3
- **Store data & metadata**
see chapter 4
- **Standardise data & metadata**
see chapter 5



How to improve



Veluwe Metadata Portal

[Map](#) [Table](#) [Add Entry](#) [About](#)

Register your dataset

Metadata submission date *

Date of registration of your dataset in the Veluwe Metadata Portal.

Language *

Language used in this form

Metadata provider

A metadata provider is the person who created and provided the documentation and other metadata for a dataset. In other words, who are you?

Name *

Your first and last name.

Organisation name

The name of the organisation you are affiliated with.

Email address

This email address may serve as a point of contact for LTER-LIFE in case there are questions about the metadata form you are currently submitting. NB: by providing this

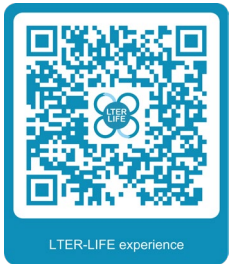
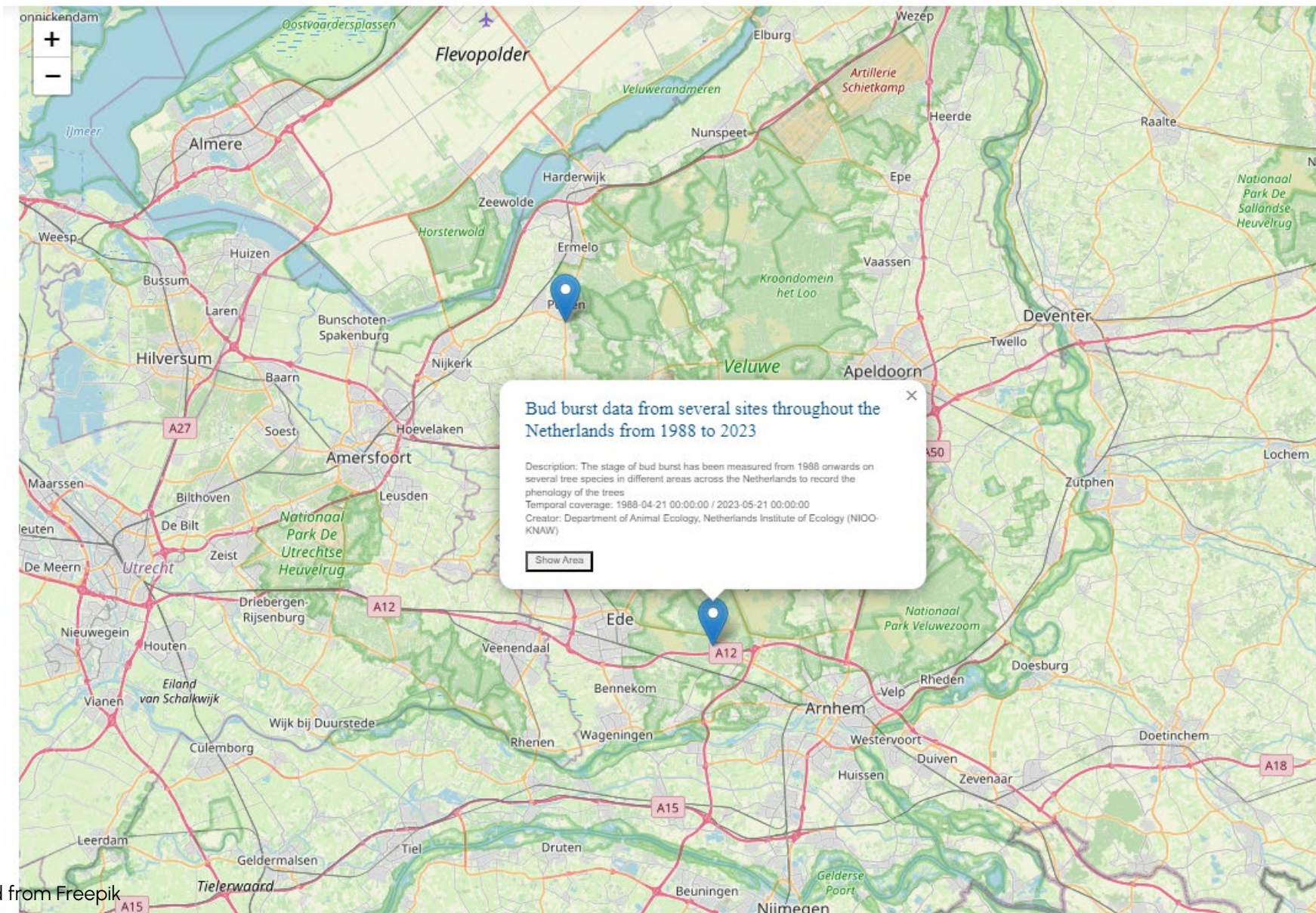


Illustration: Stefan Vriend, adapted from Freepik



Veluwe Metadata Portal

Map T



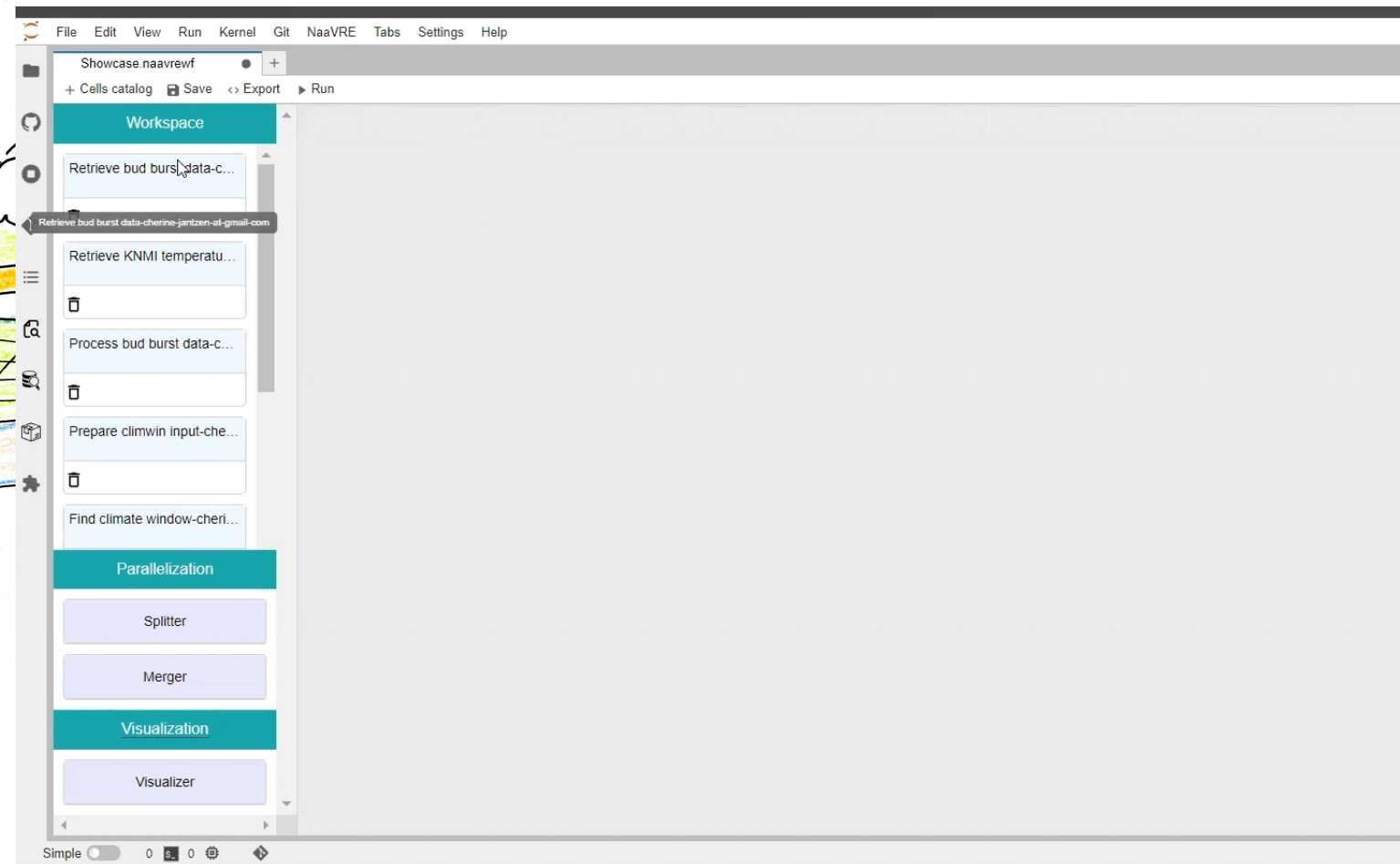


LTER-LIFE experience



Notebook as a
Virtual
Research
Environment

<https://naavre.net/>





```

}

## 2. Calculate windows for each species of interest ####
first_window_Qrobur <- find_climate_window(biological_data = avg_annual_budburs
  dplyr::filter(stringr::str_detect(
    climate_data = temp,
    window_number = "first",
    reference_day = c(31, 5),
    range = c(181, 0))

# show start and end date
first_window_Qrobur$start_date
first_window_Qrobur$end_date

# save model output
firstWindow_file <- "/tmp/data/climwin_outputs_Qrobur.rda"
save(first_window_Qrobur, file = firstWindow_file)

[10]: # Plot climate window output
# ---
# NaaVRE:
# cell:
# inputs:
# - firstWindow_file: String
# dependencies:
# - name: dplyr
# - name: purrr
# - name: stringr
# - name: lubridate
# - name: climvin
# - name: ggpubr
# ...

# Load model output data
load(firstWindow_file)

# II. Visualize output of climvin -----

```

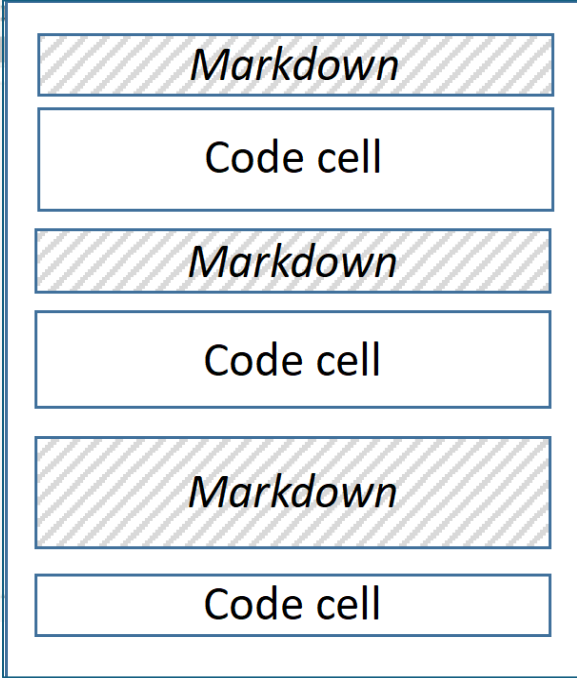
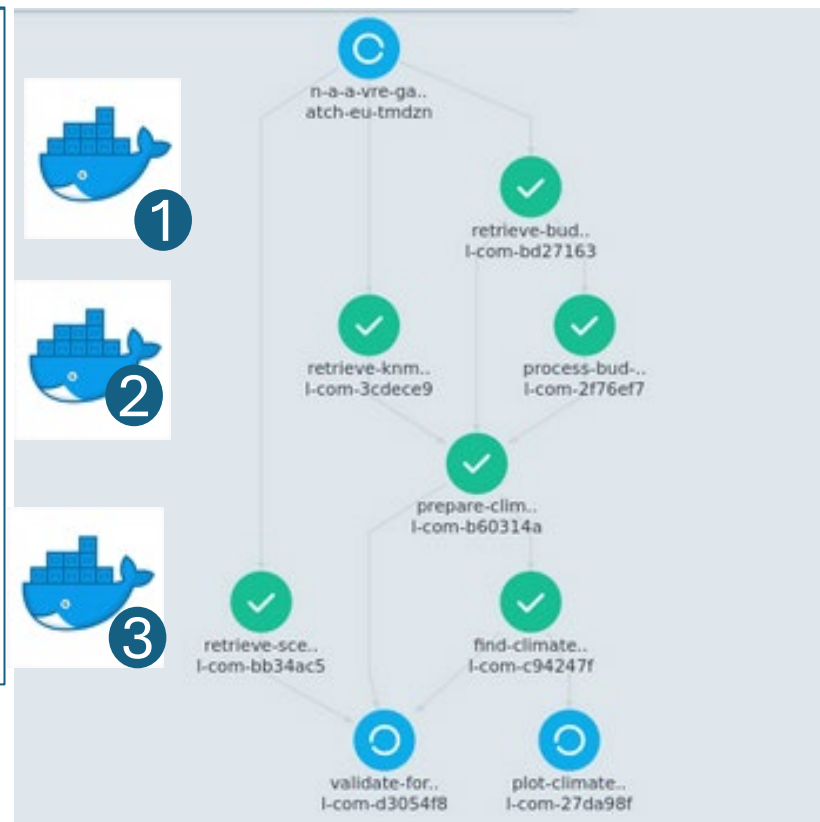


Illustration: Stefan Vriend, adapted from Freepik

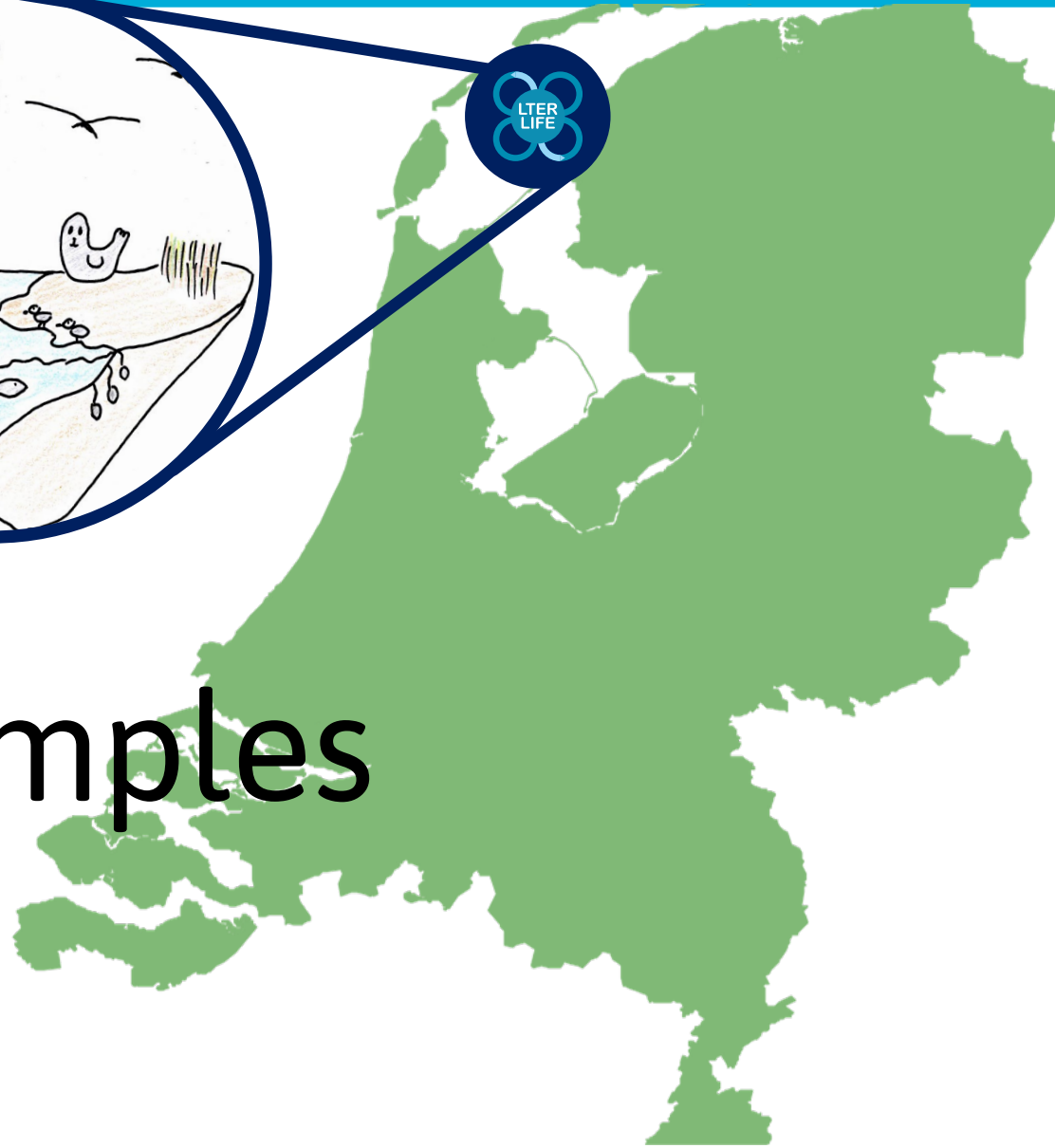


<https://naavre.net/>



Some examples

Waddensea





Becky

organisation

NIOZ

job

Senior researcher

background

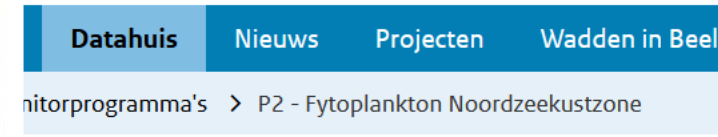
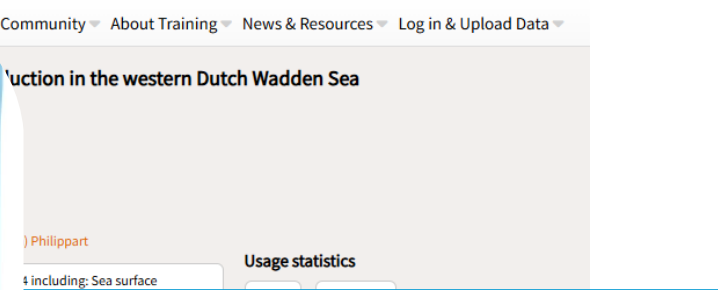
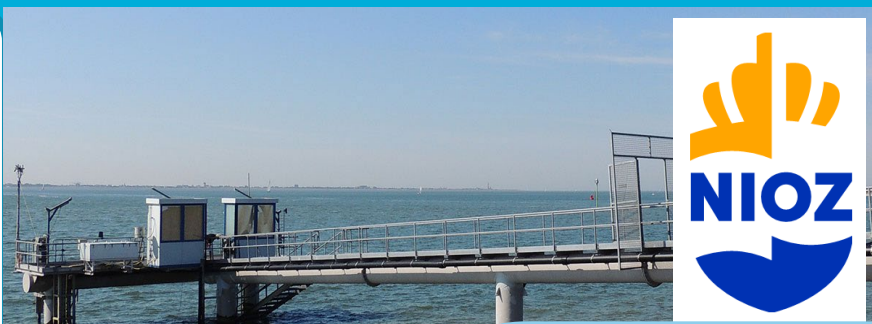
Oceanography

role:

Carbon modeller

I want to let my
postdocs **map** the
pelagic primary
productivity through
time

so that I **can**
improve estimates
of annual carbon
budgets of the
Waddensea



Noordzeekustzone

a's Waddengebied WaLTER, onderdeel plankton, a

Titel/naam meet/monitorprogramma

Fytoplanktonmonitoring in Nederlandse kustwateren en Noordzee.

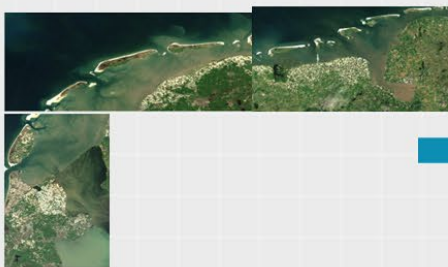
Naam aansturende organisatie (+ beheer metadata)



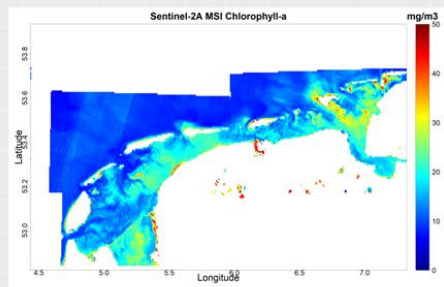
Illustration: Stefan Vriend, adapted from Freepik



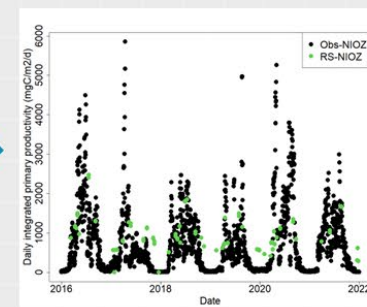
Raw satellite image



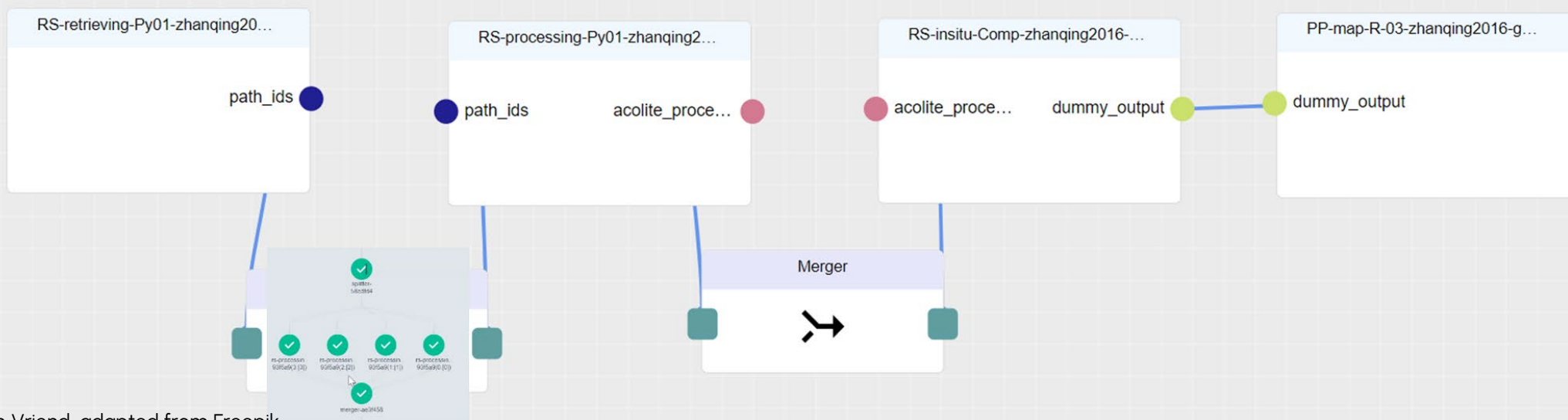
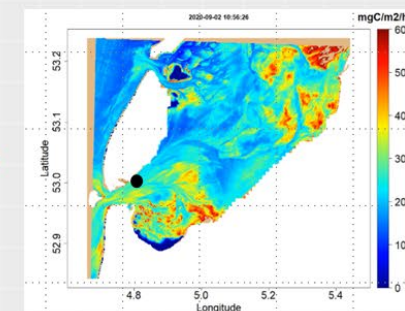
Chl-a processing



Validation by in-situ measurements



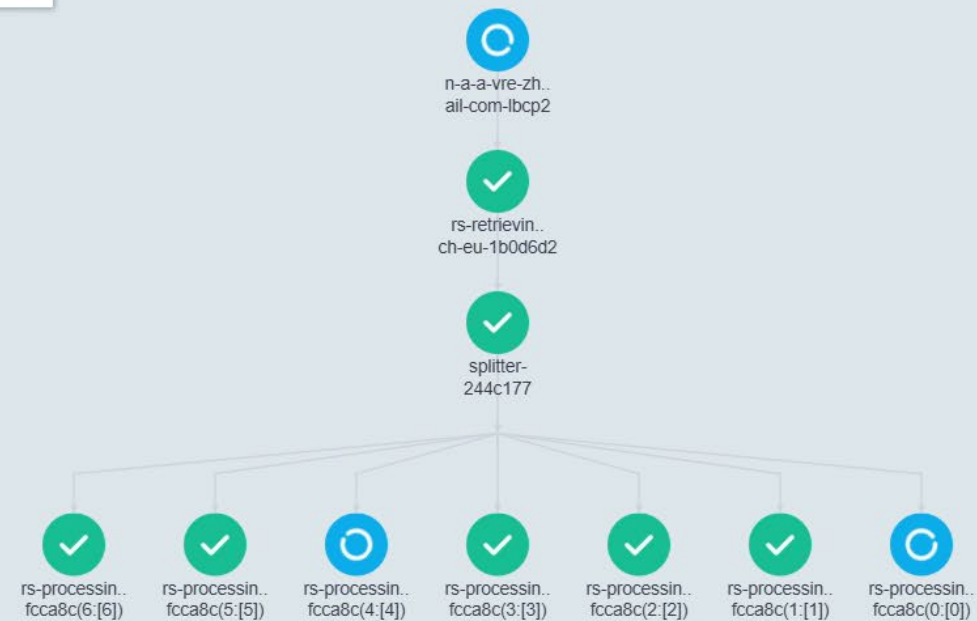
Primary production mapping

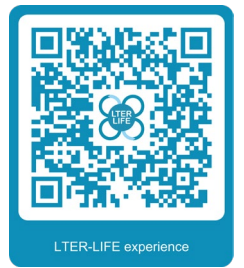




Workflows / [argo](#) / n-a-a-vre-zhanqing2016-gmail-com-lbcp2

[+ RESUBMIT](#) [|| SUSPEND](#) [■ STOP](#) [✕ TERMINATE](#) [🗑 DELETE](#) [☰ LOGS](#) [🔗 SHARE](#)





Primary production Data Visualization

Configuration

Selecting the region and variables you want to visualize, adjust remaining settings as needed, then click "Load"

Select which part of the wadden sea to view. The remote sensing data is partitioned into different tiles (see [Sentinel-2](#)). We aggregated these tiles into a mosaic [All] to map the entire Wadden sea.

Select which region

All

Select which domain to display

Pelagic

Year

2019

Rijkswaterstraat stations

View full satellite [chl-a] or derived integrated primary production estimated from established empirical model

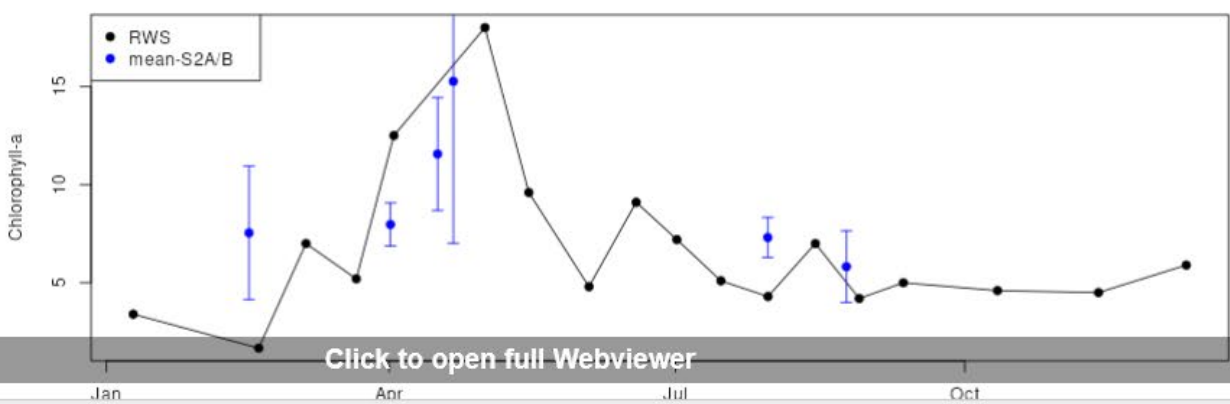
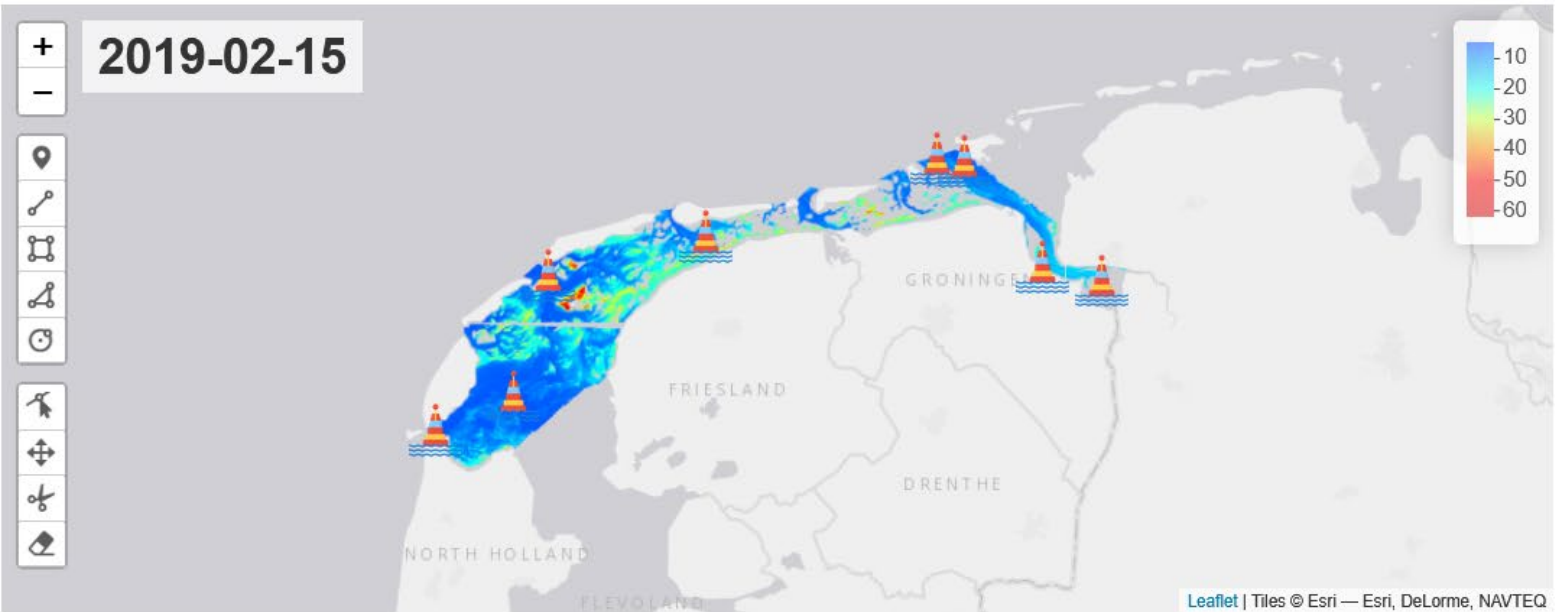
- ☒ chlorophyll-a concentration
- ☐ Primary production

Select how you want to view the data

static

Select:

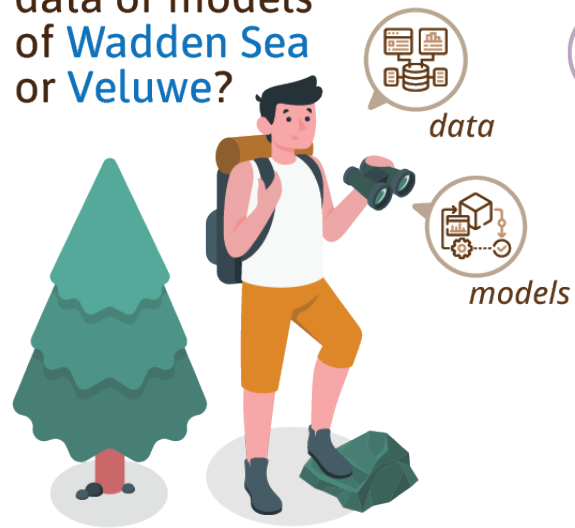
2019-02-15



Click to open full Webviewer

Join the community!

Do you have data or models of **Wadden Sea** or **Veluwe**?



Do you want to build a Digital Twin?

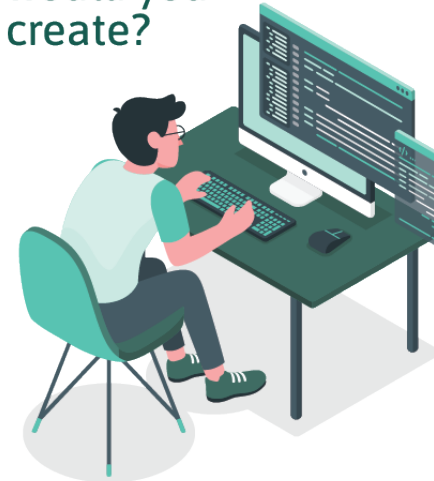


LTER-LIFE

SCAN ME

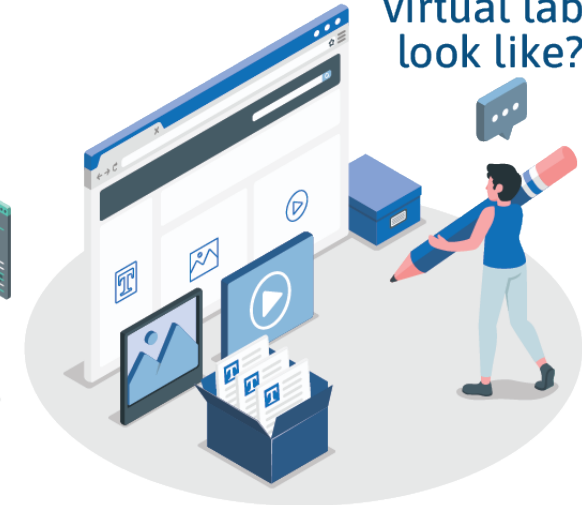
<https://lter-life.nl/en>
lter-life@nioo.knaw.nl

What digital twin would you create?



You can help!

What should the virtual lab look like?



Drawings by Geerten Hengeveld
Design by Stefan Vriend, Geerten Hengeveld
using illustrations from Storyset, Freepik, Flaticon

