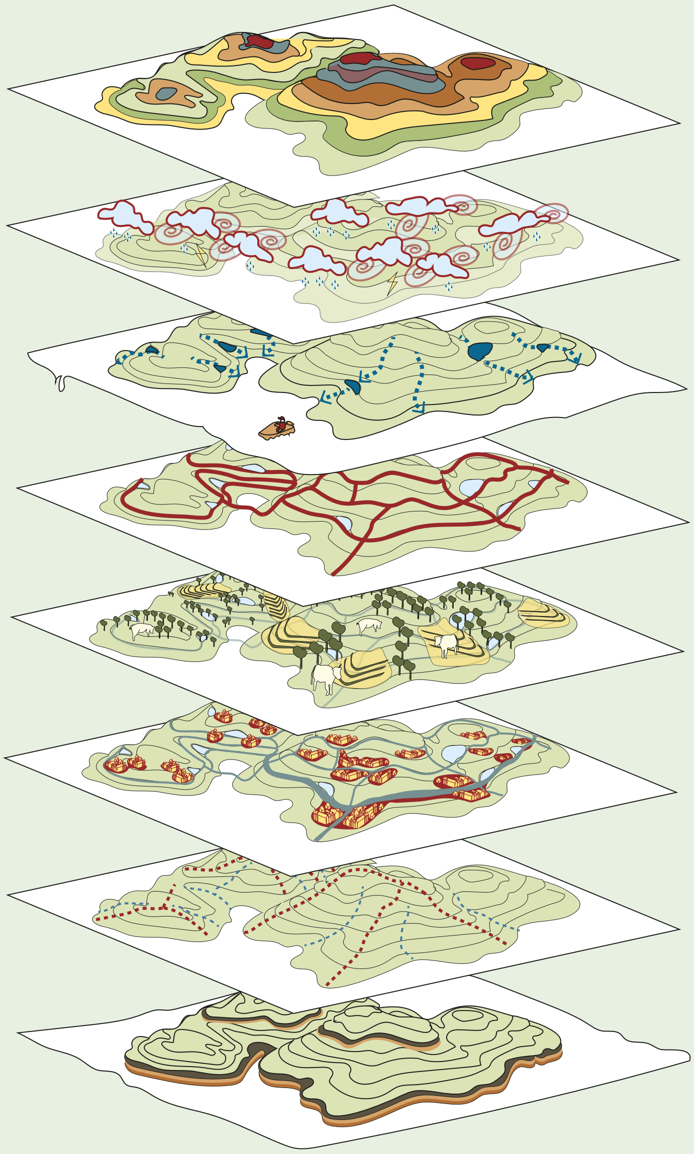
# Carbon Positive Food Regions

*Design & planning strategies to co-create regenerative food systems*

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Examiner: Marco Adelfio
Supervisor: Nils Björling

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Master Program: Design beyond sustainable development

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# Abstract

*Carbon positive food regions*, proposes a design framework and planning strategies for building a resilient food system with net negative emissions on a regional scale. The aim is to provoke regions, municipalities and nations to support the development of more regenerative agriculture that builds topsoil & heals ecosystems.

The inspiration for this master's thesis is taken from the movement of regenerative farmers in Sweden and the world. The thesis takes place in two contexts: Firstly at the heart of a 450 hectare regenerative farm called Bjällansås in Uddevalla municipality; and secondly on the municipality of Orust, an island with 15 000 inhabitants. With a design "manifesto" rooted in a process of collaborative “food system design” carried out by the daily actions of what people eat and how it shapes the landscapes around them.

The project uses a methodology of "research by design" (refered to as "design research") - with "design explorations" carried out on a farm and municipal scale primarily using the methods of backcasting and scenario planning. The design explorations also combines the methods and tools of Holistic management, Keyline design & Permaculture design into what I call a "holistic planning framework". By exploring two future scenarios of a carbon positive region, self reliant on food - the lessons from the design explorations on Bjällansås farm and Orust municipality were used to formulate "regenerative planning strategies" for physical planning.

The results are design proposals showcasing the future farm & island and the following six physical planning strategies for regional and municipal comprehensive planning; (1) a decision making framework that includes future generations, (2) eight holistic land use planning principles & design layers, (3) farmland protection & food system planning, (4) monitoring & improving ecosystem processes, (5) food nodes for sales & distribution and (6) funding and co-learning around regeneration.

The discussion explores how bottom-up and top-down actors can meet in co-creating these local regenerative food systems and potential conflicts around water and land use. Conclusions are that carbon positive food regions are possible but require ambitious targets, conscious planning and food system design with shifts to a more multifunctional mosaik landscape characterized by agroforestry, involving a multiplicity of stakeholders in the process. The designer and architect has a central role in bridging the gap between different generations, interests and scales.

**Key Words:**

regional planning,
rurbanization,
regenerative agriculture,
self-reliance, agroforestry,
climate change,
food, land-use.

# Abstrakt

## Kolinlagrande matregioner

*Planeringsstrategier för att samskapa regenerativa matsystem*

*Kolinlagrande matregioner*, är ett förslag på ett designramverk, en metod och planerings-strategier kring hur fysisk planering kan underlätta för ett regenerativt lantbruk och matsystem med nettoinlagring av kol via jordbruksmark i regional skala. Syftet är att provocera regioner, kommuner och nationer att stödja regenerativt jordbruk som bygger matjord och vitaliserar ekosystem, lokalsamhällen och lokala ekonomier.

Med utgångspunkt i två kontexter: dels i "Bjällansås gård"i Uddevalla kommun, hjärtat i en 450 ha stor gård & pionjärer inom regenerativt lantbruk med 600 nötkreatur; och dels i Orust kommun, en ö med 15 000 invånare; genomförs design-laborationer och uträkningar som utforskar gården och kommunens potential - en modell för regenerativ markanvändning som kan skalas upp regionalt för att bygga matjord och läka ekosystem.

Genom en metod av "design forskning" (forskning genom design) utforskades två framtidsscenarion av en koldioxidpositiv och självförsörjande region och hur det påverkar Bjällansås gård och Orust kommun. Mer specifikt gjordes "design-experiment" utifrån en önsvärd framtid - kallat "backcasting". I dessa design experiment användes en metodik som kombinerar Holistic management, Keyline Design och permakulturdesign till ett "Holistiskt planerings-ramverk" och baseras på en filosofi kring "matsystemdesign" där vad människor äter formar deras lokala landskap.

Resultat och insikter från design-experimenten användes för att visualisera kommunen och gårdens framtid - samt destillerades till följande sex "*regenerativa fysiska planeringsstrategier*" att använda i regionala och kommunala översiktsplaner och detaljplaner; (1) en holistiskt kontext som inkluderar framtida generationer, (2) holistiska principer för markanvändningsplanering, (3) planering & skydd av jordbruksmark och matsystem-design, (4) mätverktyg för att förbättra ekosystemprocesser, (5) matnoder för försäljning, distribution & möten och (6) finansiering och kollaborativa lärandeprocesser.

Diskussionen utforskar hur gräsrotsaktörer & samhällsplanerare kan samskapa lokala regenerativa livsmedelssystem samt potentiella konflikter kring vatten- och markanvändning. Slutsatsen är att koldinlagrande livsmedelsregioner är möjliga men kräver ambitiösa mål, medveten planering och design samt ett skifte till en mer multifunktionell markanvändning kännetecknad av agroforestry. Arkitekter och designers har en central roll i att överbrygga klyftor mellan olika generationer, intressen och skalor genom en kollaborativ designprocess där en mångfald av aktörer involveras.

**Nyckelord:**

regional planering, rurbanisering,
självförsörjning, samhushållning
mat, markanvändning,
regenerativt jordbruk, agroforestry
kolinlagring, klimatförändringar

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# Foreword

## About me:

My name is Jonathan Naraine and apart from my master degree in architecture at Chalmers, I have also worked as a "food system designer" for many years. I took a break after my bachelor degree in architecture (the first 3 years) and co-founded *The Foodprint Lab Architects* in late 2015 together with two other planners and architects. Since then I have designed everything from rooftop farms, popup parks and urban farms for both private and public property owners to greenhouses and off grid cabins in the rural context of the price winning ecotourism site *Swedish Country Living*. I also co-founded and launched Northern Europe's first land matchmaking platform for urban farming in 2016 - *Grow-Here.com* - matching unused land with people who want to farm.

I am passionate about regenerative agriculture and as I am writing this master's thesis I am currently taking a one year course in "*regenerative agriculture and holistic management*" at Bäckedals folkhögskola in parallel to my final year at the master program. Here I have learned not just about regenerative agriculture methods and strategies but also how to use holistic management and its tools for decision making towards a regenerative outcome in my personal life, in organisations and on farms. I have learned everything from monitoring ecosystem vitality, to making regenerative financial plans, holistic grazing plans and conflict resolution. I want to give big thank you to all teachers in this course which has inspired me a great deal.

*Our current system of food production and consumption is falling into it's grave.*

*As a passionate food activist in a worldwide network of change makers - I can see that there already is a more local, good, clean and fair food system growing in the ashes of the old one..*

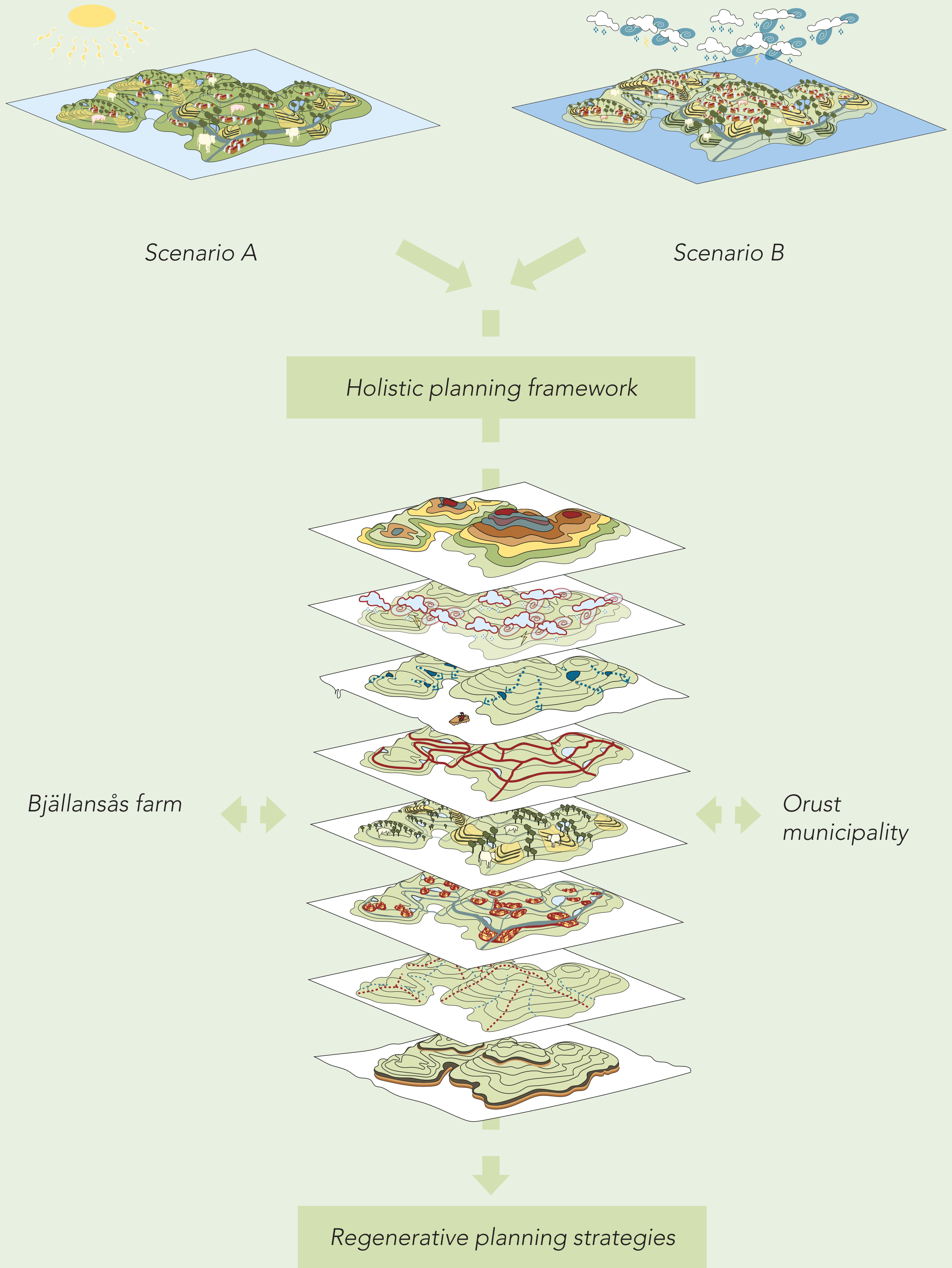
*As an architect it is my duty to prepare our cities and villages for this change that is coming - while also empowering communities to become more resilient. Architecture for the rise of a new food system. Or as I call it - conscious "food system design"...*

## How to read this booklet

You are free to read this booklet as you wish. You can jump right to the parts you find most interesting. F.ex. if you're keen to see the design explorations and the "regenerative planning strategies" you can jump straight to chapter 3.

However this thesis is best read in chronological order. It's ideal if you first read the introduction in *Setting the stage* (chapter 1) and then enjoy learning the *Key terms* (in chapter 2). I promise a lot of inspiration and new insights on the topic of food, climate and planning. This way you will also better understand the terms and methods that I will be using and applying on a farm and municipality in the *Design* chapter. Finally, don't miss the *Discussion* chapter including some of my key take aways and action points for regions, municipalities and all of us who eat food. Enjoy!

# 1. Setting the stage






# 1.1. Aim & focus

### Project Aim:

*The projects aims to to provoke municipalities, regions and nations to set more ambitious goals and dare to plan for more regenerative land use and support regenerative agriculture - by giving physical planners practical tools and strategies for regenerative comprehensive planning.*

*A secondary aim is to empower existing bottom up initiatives to scale up their impact and inspire them to form partnerships and co-design our future food regions in partnership between farmers, land owners and local inhabitants.*

### Delimitations

In order to delimit my work I will mainly focus on aspects of food production and land use and some aspects of ocean farming as a key driver in a carbon positive society. Timber and other material for fuel production will not be the focus in my work but more the general divisions of land use with numbers of how land is used in a regional and municipal scale. Illustrating potential shifts in land use needed for carbon positive food regions. My focus will primarily be on land regeneration through holistic planned grazing, small scale ”no till farming” and a diversified multifunctional use of land were farming is integrating forestry, biodiversity habitat, housing, recreation and other values on the same land. Placement of housing in relation to farmland will be explored in a general sense in terms of land use footprints in my case study's at the planning scale, but housing itself will not be the focus of my work. Rather the focus will be on how regenerative agriculture and land management can "lead the way" as a main strategy towards a carbon positive society and a regenerative regional economy.

### Research Question:

*How can design and planning enable the co-creation of carbon positive food regions, and what strategies can be used by planners and architects to support regenerative agriculture and land use?*

# 1.2. Background

*How we act in the next 10 years impacts the coming hundreds/thousands of years. It's not enough to decrease emissions, we need to start sequestering carbon on a global scale, Paul Hawken claims.* (Tickel, 2020)

## Relevance:

Sweden and its adminsitrative regions has set goals of carbon neutrality that will also require carbon sequestration. In October 2021 a proposal (motion) was put forward and positively received on national efforts to support regenerative agriculture and pay farmers for carbon sequestration (Sveriges Riksdag, 2021).

## Need to move beyond sustainability

Carbon sequestration is not the only goal of this thesis but chosen primarily as a catchy title to get a variety of actors "on board". What the project aims to express is the fact that climate change is only one of several symptoms of the underlying issues we are facing in our destructive (degenerative) society that undermines the *future resource base* of present and coming generations (Avis et al, 2021; Palmer, 2020) - and other symptoms include biodiversity loss, the loss of topsoil - at a rate that leaves us with no fertile soil left to grow our food very soon (Qwiberg, 2017; Kempf, 2020). In fact our current way of farming and use of pesticides means "*we are on track to go exctinct as a species in the next 70 years*" according to American physician and medical doctor Zach Bush (Kempf, 2020, 18 min).

## Soil carbon - a foundation of life

The solution cannot be found in what is called "sustainable", as it focuses solely on decreasing our negative impact when we now have to start repairing the damage we have caused and heal our ecosystems, social communities and local economies (Avis et al, 2021; Palmer, 2020). The foundation of life on land is our soil health (Qwiberg, 2017, Brown, 2018)); - as it feeds all flora and fauna and provides all food and energy for humans. Today we are loosing our topsoil at rates much faster than it is created and this threathens to collapse our global civilisation (P3, 2022).

### A new paradigm

Conclusively we need to move beyond the reductionism thinking (in the sustainability paradigm) of seeing climate and carbon as the only question (Avis et al, 2021; Palmer, 2020) - to a *regenerative paradigm* and holistic understanding and the bigger picture of soil and ecosystem health. *Soil organic carbon* is the fuel source for both microbes and plants and crucial for a healthy soil ecosystem according to scientist Christine Jones (Brown, 2017) and thus it shall be seen not just as something bad we need to mitigate but as the foundation of life on earth our civilisation (ibid; Schwartz, 2013).

*In chapter 2 you will learn more about this.*

*"We've lost an estimated 50-80% carbon in our soils over the last 150 years"*

Judith D. Schwartz *(2013, 1h 39 min)*

*" The 2020-ies will be the "decisive decade".*

Johan Rockström *(2021, last paragraph)*



# 1.3. Global challenges

## Climate & biodiversity crisis:

There are many planetary boundaries we are now exceeding according to climate scientist Johan Rockström (2015). The most urgent ones are perhaps climate change and exponential biodiversity loss (the 6th mass excinction) but also the cycles of Nitrogen and Phosphourous that are out of balance. The way we farm is connected with "almost all planetary boundaries" says Rockström (2015, p.11). Agriculture and land use is thus the biggest contributer and potential solution to most of these challenges.

## Food crisis already in 2050:

Not only will climate change lead to death due the direct impact of weather and sea level rise leading to climate refugees - but according to American climate and food scientist David Battisti "*these are really small problems compared to feeding the world*" (P3 Dystopi, 2018, 7 min). Even in the best case scenario, yields will decrease with 20% to 2050 (ibid). The world population will increase to 9,8 billion people to 2050 according to the *World Population Prospects* report by UN (2017) and degraded soils coupled with climate change will likely decrease our ability to feed ourselves leading to a global food crisis or societal collapse argues American geologist David Montgomery (P3, 2022).

Julian Cribb (Australian scientific journalist) claims *"Nobody is gonna be unaffected by the food crisis. Cause it's gonna hit the entire economy (and) hit the political stability"*. He argues we will see "*a world with up to a billion refugees*" - a dangerous situation that "*can lead to war*". (P3, 2018, 7m 30 sec - 7 min 53)

## Soil erosion leading to collapse

The documentary *Sista skörden* (Qwiberg, 2017) states that if we continue to farm like we do today - in just one generation - our soils are so degraded we can no longer feed the human population. We are loosing 10 tons of topsoil per ha per year, which can be compared to 75 million ha of land equivalent to the entire area of the UK (Makepeace, 2019). In many fertile places we loose up to 200-300 tons per ha according to Ronald Vargas (P3, 2022), secretary of Global Soil Partnership at FAO. Montgomery argues soil erosion could lead to "*man made desserts*", *global famine* and the *collapse of civilization* and the solution, he claims, is a transition to regenerative agriculture (ibid).

## Wars and low self reliance:

Sweden's self sufficiency rates have steadily decreased the last decades, from 75% in 1988 to about 50% in 2019, according to Swedish statistics [SCB] (LRF, 2022). These low are in reality even lower in case of import stops as they include a depency on imported and increasingly expensive inputs such as fossile fuels, feed and chemicals (Eriksson, 2018). This makes Sweden *very vulnerable to crisis events* leading to import stops such as wars, pandemics or global trade restrictions. In spring 2022, while writing this thesis, two historical events happened - Russia invaded Ukraine leading to a war in Europe and Sweden applied to join NATO. This means the risk of such events destablizing our country has increased and increasing our food self reliance has become a matter of crisis management is a part of the civil defence reform 18 of May (Regeringskansliet, 2022). As David Montgomery mentions (P3, 2022) wars could be fought over land in a future of food shortages. The war in Ukraine already has increased prices and might lead to global food shortages from this important agricultural nation already in 2023 Swedish news reports on may 20th (SVT, 2022). The number of people globally facing *severe food shortages* has "*doubled in two years*" according to Antonio Guterres at the UN (Syre, 2022, paragraph 2).

## What's the solution?

This thesis showcases how regenerative agriculture could be a solution to many, if not most, of our current urgent sustainability challenges and create a more resilient food system to avoid global famine, wars fought over food, etc. It could regenerate our soils and ecosystems while also producing healthy food, improve biodiversity, water infiltration rates, bringing people together and create new jobs. Localising our food producting using regenerative agriculture would make us less dependent on fossile and chemical imports and more prepared for wars, pandemics, stopped imports or other crisis.

*"If we basically degrade half of our abilty to feed the planet and increase numbers (population) with another third there won't be enough food to go around. [...] And that's a recipee for societal collapse."*

David Montgomery *(P3 Dystopi, 2022, 42 min)*

Professor of Geology at Washington University

# 1.4. Context / Site

## Two scales of design:

I have carried out design research at two scales - a farm scale and a municipal scale - to explore how a carbon positive self reliant region could look. The findings from these explorations informed *design and planning strategies* that can be scaled up regionally to build topsoil and heal ecosystems all over the region.

*The design research is situated in two contexts; firstly a 450 hectare regenerative farm called Bjällansås in Uddevalla; and secondly the municipality of Orust.*

## Bjällansås farm:

The design research will start in the context of the regenerative farm called Bjällansås in Uddevalla - a 450 hectare farm (including scattered grazing areas across 3 municipalities. Here the farmers (Jan Karlsson and his daughter Märta Jansdotter) have been pioneers in organic and regenerative agriculture. They farm on mostly lended and rented land as they have built up a network of land owners giving them access to graze their 600 cows in a way that regenerates the land. With lots of experience, social capital and access to land they could become a model farm where other people could learn about regenerative agriculture. In this project I aim to illustrate a vision of how this can come about by creating a diverse set of farming enterprises that could be scaled across the region.

## Orust

Orust municipality is currently developing a new comprehensive plan and my master's thesis aims to contribute to this process by giving some input on potential strategies and goals of increasing local food production and regenerate soils, land and ocean ecosystems. Orust is a great case study of how a whole municipality and island could adopt regenerative agriculture to feed themselves and increase their resilience in an increasingly uncertain world. The question will be asked: Can Orust become carbon positive while also feeding an increasing population?

# 1.5. Methodology

## Design research

My main methodology is based on "*design research*" and specifically the approach of "*design exploration*" Design research defines the very activities of design as a way of researching and producing knowledge (Downton, 2003). According to Daniel Fallman (2008) there are three different perspectives and approaches to carry out design research activity - one of them being "design exploration". Design exploration asks the question "*What if*?" and design can be used to provoke and become a statement of what is possible (ibid).

## Back casting & Scenario planning

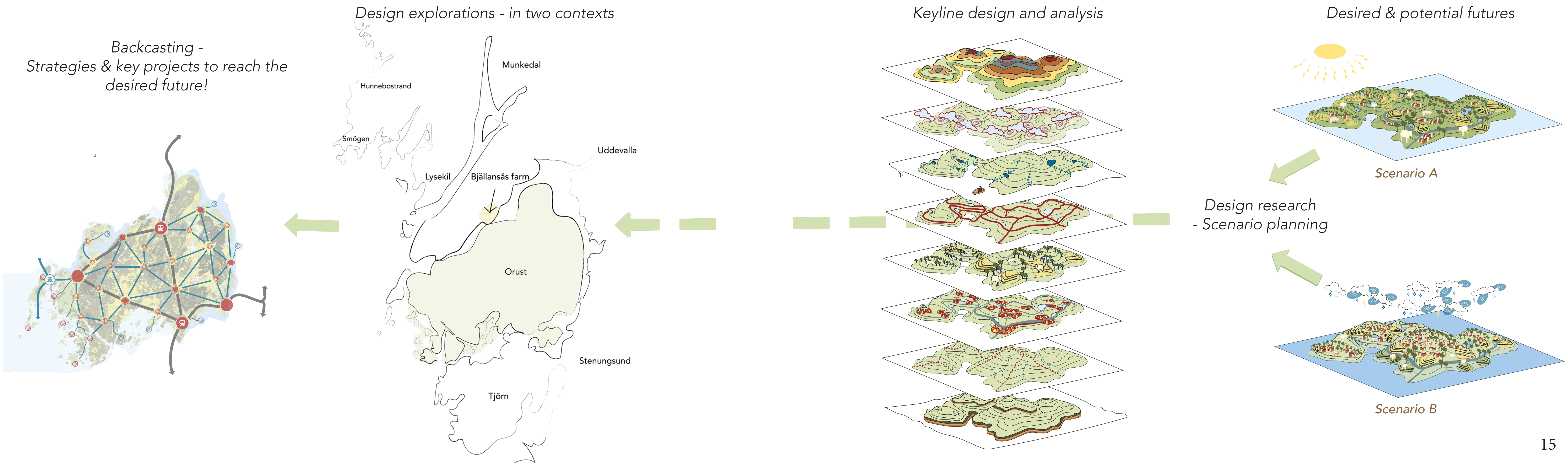
The backbone of my methodology are the strategies of backcasting and scenario planning. *Scenario planning* is about identifying several different future scenarios as a method of understanding potential future changes and to be better prepared for theses various scenarios. In the final report of the project "Framsyn" by Region 2050 (Reglab, 2019) they present three various methods of scenario planning - probable futures, potential futures and *desirable futures* (backcasting). According to John. B. Robinson (2003) *backcasting* is a form of "*normative scenario analysis*" envisioning a desired future and then identifying the steps needed to get to this future (ibid).

I started by exploring two scenarios (an urbanized and a ruralized region) but choose to focus more on the one I determined most desirable one to implement the method of backcasting on that future in relation to the two contexts where my design explorations take place. The choosen scenario is the ”*urbanized*” region (*Scenario A*). However I do explore both scenarios to some degree in both Orust and Västra Götaland.

## Methods used in my design explorations

The design methods I used in my backcasting explorations is a combination of tools and methods I call the "*holistic planning framework*". To identify the key interventions to get towards this desired future, my methods has been:

- *Holistic planning framework: using Keyline® design and geographical analysis (see next page).*
- *Interviews and feedback sessions with stakeholders & site visits*
- *GIS-analysis and statistics of current land use & calculations of future land use needs.*



# 1.5. Design frameworks

## *A holistic planning framework*

My design explorations are based on what I call "*a holistic planning framework*" based in the combined methods of *keyline design*, *permaculture design* and *holistic management*, inspired by (1) Darren Doherty (2021), and his Australian company *Regrarians* teaching large scale adoption these methods to farmers and land managers globally, (2) Richard Perkins (2019) practicing these three methods in Värmland, Sweden and (3) Rob Avis et al (2021) developing a design process using these methods.

### Keyline design:

Developed by P.A. Yeomans (1958) almost 80 years ago the *Keyline® plan* is described as the first integrated comprehensive design system for agricultural and urban development (Perkins, 2019) - and is a method and framework to help us find the optimal location of elements in the landscape. The "*Keyline Scale of Permanence*" (KSOP) provides a great organizing pattern for land design as attested by many regenerative farm designers (ibid; Doherty, 2021).

### Permaculture design process:

Inspired by the book "Building your permaculture property" (Avis et al, 2021) I applied an adaptation of their design process where you analyse the landscape using the "design layers" (inspired by Yeomans' KSOP) into a SWOT analysis that informs your design goals and strategies.

### Holistic management

Holistic Management is a framework for desicion making often used in regenerative agriculture and is based on creating a holistic context (vision and values). Their framework for decision has been shown to regenerate both land, communities and economies. This work is also integrated with both methods mentioned above in the work of Perkins, Doherty and Avis et al.

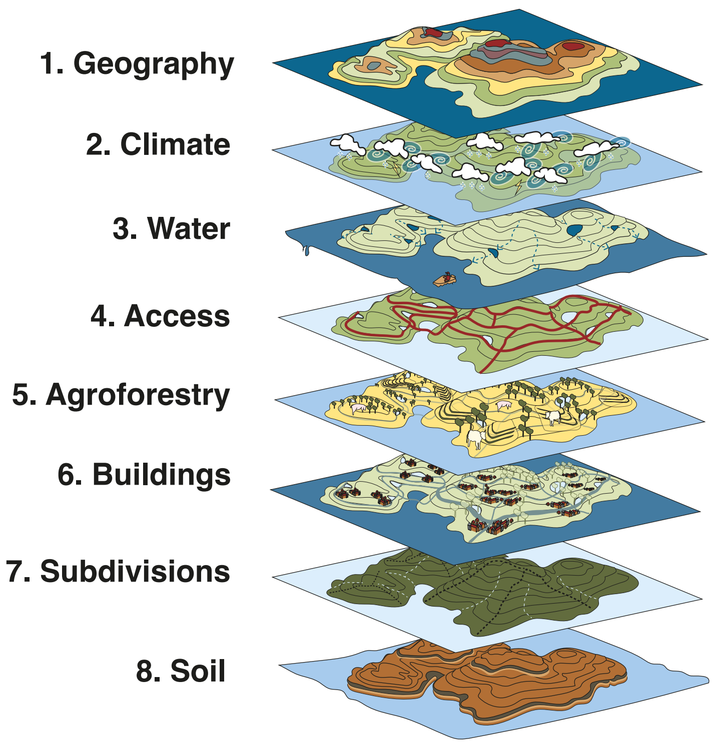


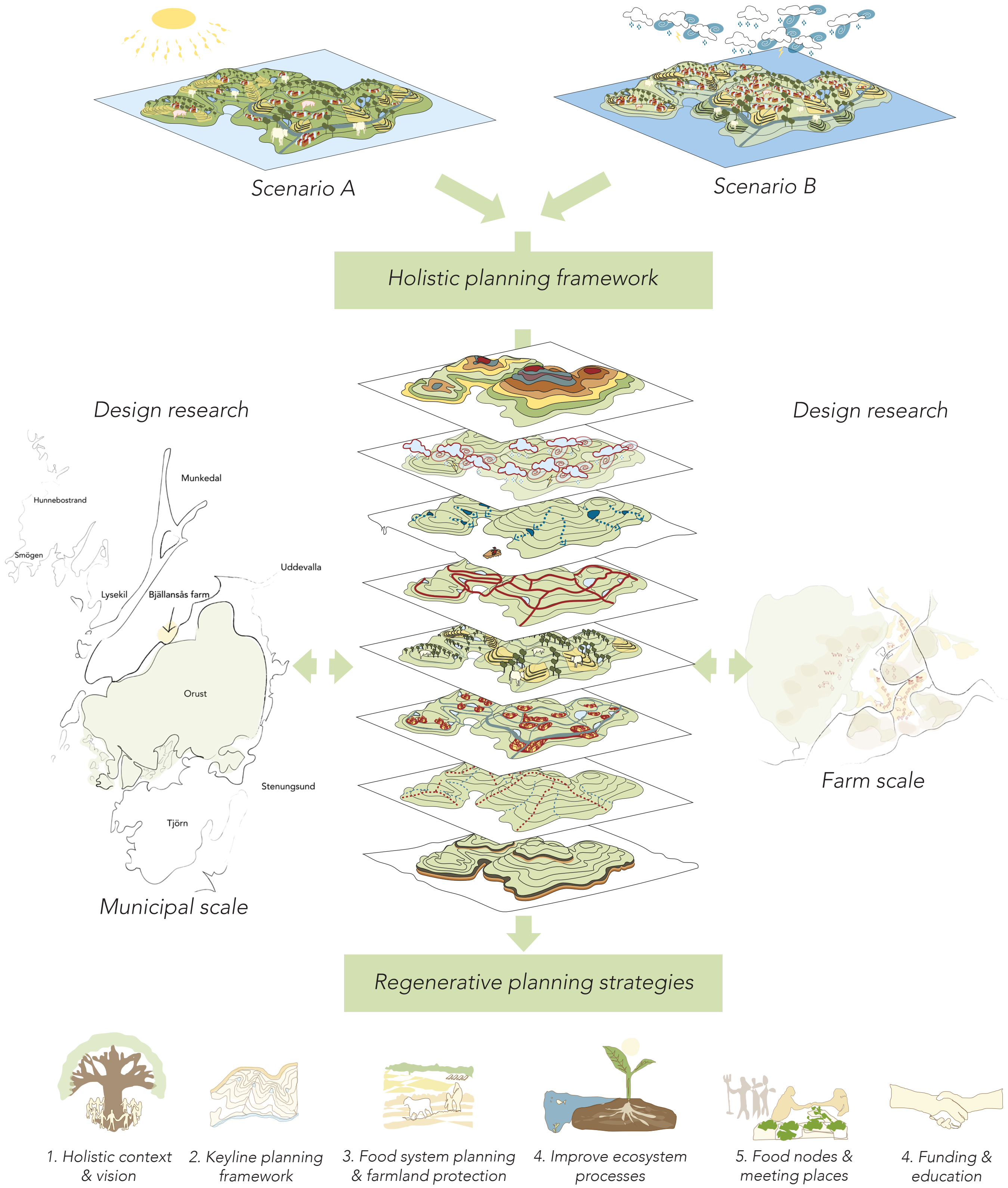

*Diagram summarizing the Keyline® Scale of Permanence (Yeomans, 1958) inspired by later adaptations by Regrarians (Doherty, 2021), and the illustrations by Jarret Sitter of the design layers done for the Permaculture book mentioned above (Avis et al, 2021).*



# 1.6. Project output

### Regenerative Planning Strategies

The outcome of my design explorations and design research using backcasting and the "*holistic planning framework*" will result in Regenerative Planning Strategies for comprehensive planning in municipalities and regions.



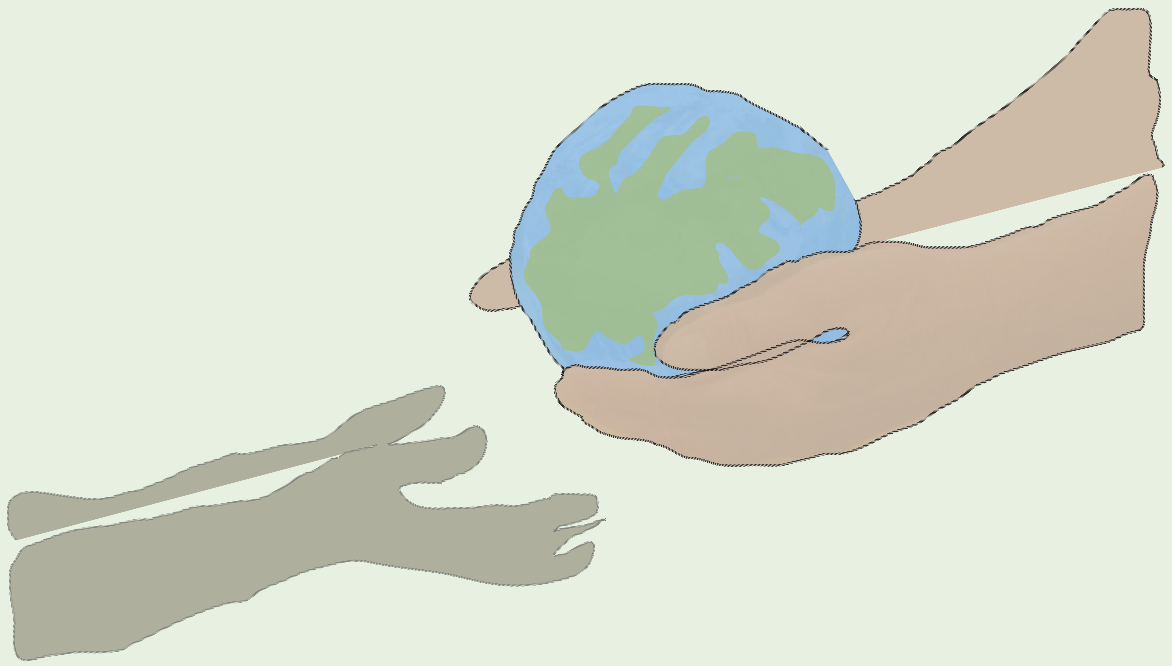
# 2. Key terms

*Introducing principles, design methods & management tools for regenerative land use*

## Let's dive into some of the key terms!

In this chapter we will explore the main design frameworks I have been using and combining into my own *Holistic design and planning frameworks* including Keyline design, Holistic management and the principles and theoretical terms and definitions of regenerative agriculture, soil health, carbon sequestration and food regions. Finally we will also take a look at what food system design means and how we can all be a part of it.

First let's explore some of the principles and frameworks around regenerative agriculture.





# 2.1. Regenerative Agriculture

## What is Regenerative agriculture?

*"To enable the highest possible vitality in ecosystems by fulfilling human needs"*

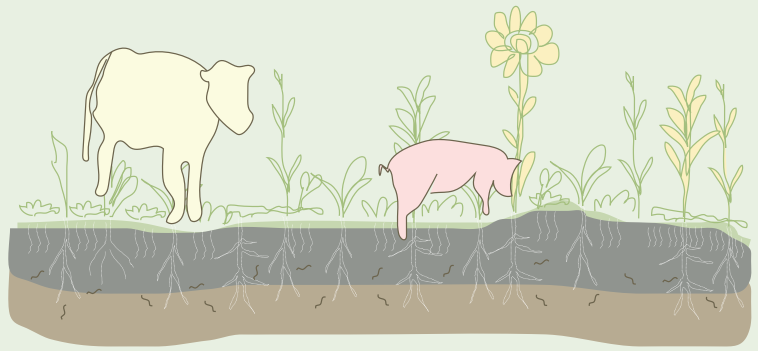
**Jörgen Andersson**

*(2021, fb-group description)*

This is the definition by the Nordic network and hub of the Savory institute and basically means that you manage the land in a way which vitalizes ecosystems over time while also growing food or providing for other human needs (Andersson, 2021). An agriculture that is not just less bad but actually has a good impact.

Regenerative agriculture is not a method but an outcome towards regeneration of ecosystems and communities. However there are some principles and frameworks we can use to better understand how to get here.

First let's have a look at soil health - the basis of life in so many ecosystems!



*Truly regenerative agriculture, business, economy or society needs to be based on holistic management (thinking several generations forward and include all living beings and ecosystems in the decision making).*

*My summary on defining regenerative agriculture based on a podcast interview with Allan Savory*

(Palmer, 2020)

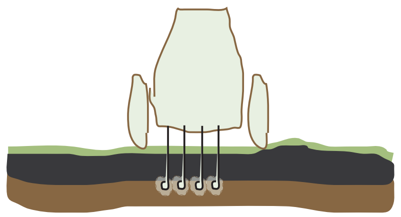
# 2.1.1. Principles of soil health

## *Principles of soil health - the basis of regenerating soil ecosystems!*

So now that we have defined what regenerative agriculture is, it is time to look into the main components of how we build healthy soils. After all, this is the goal of most regenerative farming. The principles described here were layed out by Gabe Brown in his book Dirt to soil (2018) and he says they are derived from nature through eons of time and identified by man through observation (ibid). Many scientists refer to these as the cornerstone principles of regenerative agriculture - including David Montgomery, who argues they are very much needed as the new norms of truly good agriculture (P3, 2022).

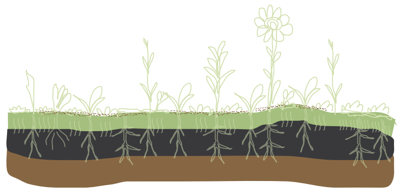
### 5 principles of soil health:

1.



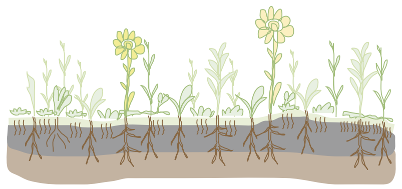
**Limited disturbance:**
Reduce tilling as it disturbs soil structures, resulting in soil erosion. Chemical pesticides and fertilizers also disturb the soil.

2.



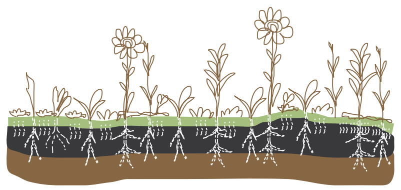
**Armor:**
Nature always works to cover the soil and protects it from wind and water erosion. F.ex. dead organic matter breaking down or living cover crops creates this armor on the soil.

3.



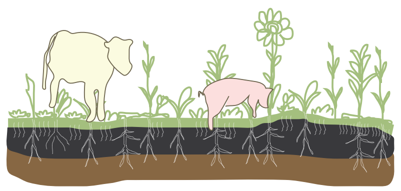
**Diversity:**
Avoid monocultures and strive for diversity. Integrate many species of plants with varying root depths and niches as it feeds a variety of microbes in the soil.

4.



**Living roots:**
Maintain a living root in the soil as long as possible. Green growing plants means living roots, feeding soil biology by providing its basic food source - carbon.

5.



**Integrating livestock:**
Grazing animals stimulates plants to pump more carbon into the soil. This drives nutrient cycling by feeding biology. It's also important to provide habitat for all fauna, birds, insects and microbiology.

(Brown, 2018. 2min 30)



# 2.1.2. Soil carbon & organic matter

## *The importance of soil organic matter*

**Soil organic matter is about 50% carbon** (Thulin, 2022; Tickell, 2020).

In the book "Dirt to soil" Gabe Brown (2018) mentions Dr. Christine Jones' scientific work on how soil carbon is the key driver for much of soil health. According to Dr. Jones, plants take in carbon dioxide from the air and create simple sugars (referred to as *photosyntate*) - the building blocks of life. Part of these sugars help build up the plants but a significant amount are transferred to the root tips - where they are "leaked into the soil" as *root exudates* (what Jones call "*liquid carbon*"). This way they feed the microbes in the soil and in turn the plants benefits from the nutrients released from the soil by the microbes. A "win win" relationship referred to as the *liquid carbon pathway*. Microbial activity also drive processes of soil aggregation, structure and aeration, infiltration and water holding capacity. This, explained by Jones is the basis of the formation of soil organic matter. (Brown, 2018)

## *Carbon feeds all life!*

The process of which carbon is created in the soil is what makes it alive (ibid). Soil with no organic matter is essentially dead, like sand or dust, and has no capacity to hold water or nutrients making it virtually impossible to farm in it (ibid; Qwiberg, 2017). Rather it will likely blow away (wind erosion) leading to big crisis events similar to the *great dustball* in the Great Plains of the US in the 1930-ies where it was "pitch black" and no one could go out without the risk of choking to death by breating in dust (P3 et al, 2022; Tickell, 2017). As explained by Jones (Brown, 2018), in healthy soils plant roots generously give away sugars via the "*liquid carbon pathway*" - crucial to soil building and essential to the production of *humus* (a long lived from of organic carbon). This plant-microbe relationship is key to life both above and below soil as explained by Brown (2018). So let's build soil carbon!

## *Effective rainfall*

Effective rainfall is more important than actual rainfall - and essentially means how much of the water falling on your land can infiltrate into your soil and be stored there (Brown, 2018). Soil carbon holds 20 times of it's weight in water (Makepeace, 2019).

> *"The work of photo-synthesis exceeds the total of the world industry by a factor of nine. Plants then move many times more carbon molecules than does the burning of fossil fuels."*
>
> **Judith D. Schwartz** (2017, 1h 27 m)

## *Water infiltration*

**Browns regenerative farm**
in the US has seen water infiltration rates increasing significantly from 1991 (½ inch per hour) to 2015 (2 inches in 25 seconds). As Gabe Brown explains (2018), this is due to the increase in soil carbon and its ability to hold water.

**The example of Gotland:**
By doubling soil organic matter from 4 to 8%* on the island of Gotland we could make the soil capture 113 million cubic meters of water per year biologist Gunnar Thulin explains (2022). This is double the amount of water being lost from the islands watershed each year due to negative water balance (ibid). *(600mm rainfall - 400 evaporated and 220mm run off = -20mm).*

*down to 50 cm on 75 000 ha of farmland

# 2.1.3 Keyline® design

## *Introducing the Keyline® plan and the Scale of Permanence*

### Keyline® planning

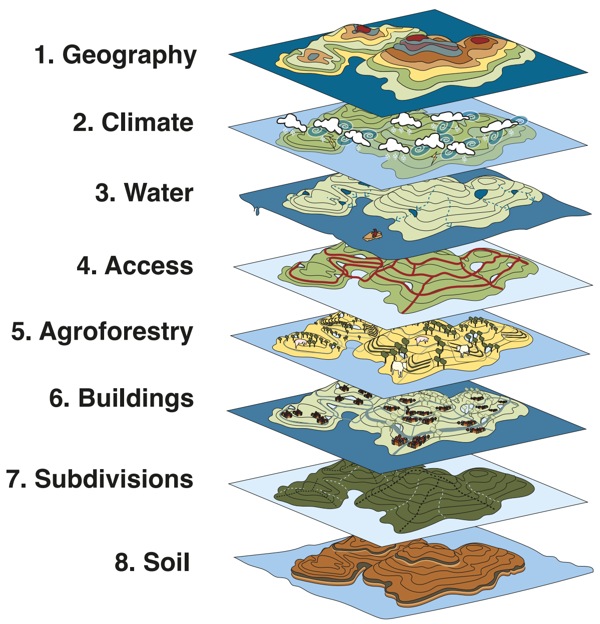
Another useful design tool and process is the *Keyline® plan* developed by P.A. Yeomans (1958) where he formulated a method of reading the landscape and letting the landform and water flows (as more permanent aspects of the landscape) be the basis for designing and planning our cities, farms and productive landscapes. The tool enables an optimal placement of roads, buildings and forestry to ultimately catch and store more water and speed up the building of healthy topsoil.

### Keyline Scale of Permanence

The original *Keyline® Scale of Permanence* was presented in Yeomans first book (1958) and it has been further developed by many. In the illustration below you can see how it has been adapted by the Regrarians platform (Doherty, 2021) and Avis et al (2021).

### So what is the Keyline® plan?

What Yeomans calls the *Keyline® plan* is not really about creating a masterplan, it's more about reading and understanding the landscape and where to place each element according to the *Keyline® Scale of Permanence* (KSOP). By following each layer in sequence each following layer is determined by the previous one, ultimately dictated by the landscapes topography and geography (Doherty, 2021; Perkins, 2019).




*"The landscape imposes itself on the planner. The planner doesn't put geometrical patterns on the land in Keyline."*

**P. A. Yeomans**
(1979, part 1, 11:30 min)

*Above is the Scale of Permanence (KSOP) adapted by Regrarians (Doherty, 2021). Just like in the adaption of Avis et al (2021) in their book "Building you permaculture property "I have changed the order of Climate and Geography. In the original KSOP by Yeomans (1958) as well as in the Regrarians version - Climate is the first layer of permanence, that is hardest to change. Regrarians also include the holistic context from HM in the first layer as a "climate of the mind".*

*Illustration inspired by Jarret Sitter.*



# 2.1.3 Keyline® design

## *Keyline geometry and cultivation patterns*

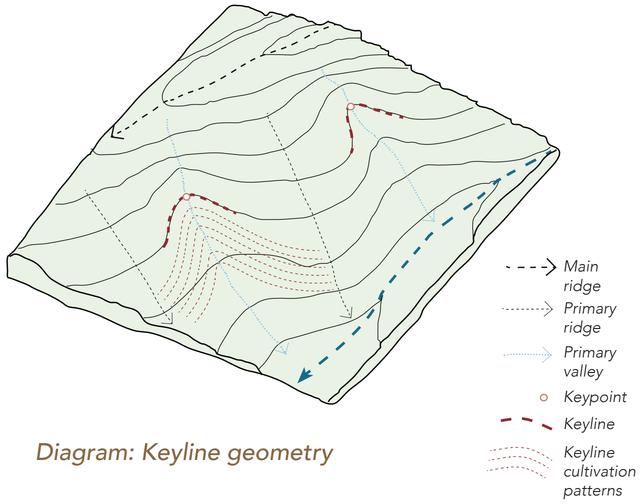



*Diagram: Keyline geometry*

### Keyline geography

These are the main terms used in Keyline design and analysis to understand landscapes by dividing them into "*landform elements*" to be able to read geography:

- Main ridge *(diving landscapes into watersheds)*
- Primary ridge *(as fingers from the main ridges)*
- Primary valleys *(the low line where water often flows between primary ridges)*
- Primary land units *(between ridges)*
- Key point *(the "inflection point" in the primary valley where the steep hill transforms into a more flat plain)*
- Keyline *(contour line from keypoint to inflection point - in the middle of the ridge and valley).*

(Doherty, 2017; Booth, 1979; Perkins, 2019, Millison, 2020)

### The Keyline is "key"

When we have identified the Keyline, we also have found the highest possible location for a pond (Water storage). Keylines are descending the further down on the ridge you go, meaning the overflow from pond 1 can irrigate pond 2 etc (Doherty, 2017 & 2020; Millison, 2020).

### Building topsoil through grazing and subsoiling

PA Yeomans tells us in an video interview (Booth, 1979) that he produced 18-20 cm of additional topsoil in just 3 years through a technique of grazing and subsoiling transforming subsoil into topsoil. A subsoiler breaks up the hardpan created by traditional ploughing. So how does this work?

### Keyline subsoil plowing

By aerating the soil through Keyline subsoil plough (bunyip), developed by Yeomans and his sons, we can speed up the formation of topsoil from subsoil (Booth, 1979). Aerating the subsoil and removing compacted soil barriers will put it in a condition to take in more water as roots can penetrate deeper. Following *keyline cultivation patterns* slightly off contour to move water to dry ridges away from wet valleys the subsoiling can spread water out more across the landscape. As subsoiling combined with grazing allow roots to reach deeper into the ground the subsoil layers become aerated and plant roots also bring life and organic matter into this subsoil layer - a process which transforms it into hummus-rich topsoil (ibid; Perkins, 2019; Doherty, 2021). Richard Perkins (2019) has been able to create 20cm of topsoil in just 3 years using this practice.

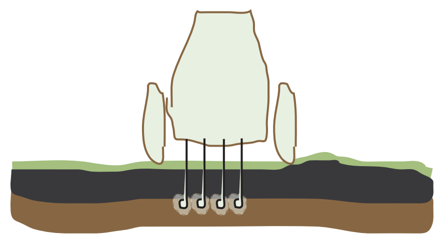


***Illustration of Keyline subsoiler:***

*Using the subsoil plough (following the "**keyline cultivation patterns**") aerates the soil without disturbing the soil surface. This allows roots to penetrate deeper into the subsoil transforming it to topsoil.*

# 2.1.4 Holistic Management

## *A framework for decision making and regenerative land management*

### Why holistic management?

In systems thinking we understand that nature functions in whole's. This is true not just in ecosystems but also in social and economic systems. These systems are based on mutualistic relationships between all actors involved, and all of these systems are highly complex, not "complicated" but "*complex*", meaning they are unpredictable and self organizing (Avis et al, 2021). We often fail to manage all these complex systems due to our *western paradigm of reductionism* - that is the basis of our dominant science and culture of a *mechanistic worldview* according to Allan Savory (Palmer, 2020).

### Holistic rather than reductionist management

A shift to regenerative land management requires a shift from reductionist decision making to holistic management - from global policy all the way down to regional level, business level and family level according to Savory (ibid) . Holistic Management [refered to as HM], means making proactive decisions based on your holistic context. Managing holistically has been tested for over 35 years and proven to be able to handle complexity (ibid).

### A holistic context:

Articulating an holistic context is the basis of HM. It's a process of defining what is important for the decision makers in question. How do you define a holistic context? Well, you start by defining these three things:

- **Wholes under managemen**
  *What wholes are you managing here? (yourself, family, farm, company) Who are the decision makers?*
- **Quality of life statement**
  *Personally and deeply, how do you want your life to be? (Ask "why" until you find the essence of "quality of life")*
- **Future resource base**
  *"What will your land have to be like 200 years from now if your great great grandchildren want to live a life like you want?"*

*Allan Savory*
(Palmer, 2020, paragraph 8)

> *"No agriculture can be truly regenerative unless it is an agriculture covering all of our Earth's surface that is managed holistically"*
>
> **Allan Savory**
> (Palmer, 2020. 8 paragraphs from bottom)



# 2.1.4 Holistic Management

## *Ecosystem processes and testing questions for a regenerative outcome*

Holistic management focuses on 4 ecosystem processes and our potential impact on them. Affecting one process often affects all. (Savory Institute, 2020; Brown, 2018)

*1. The mineral cycle*

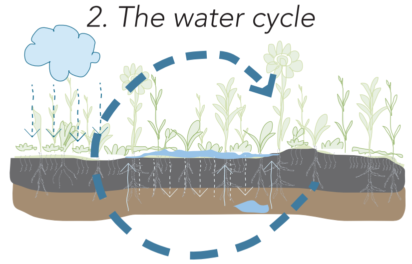

### The ecosystem processes

These processes all influence each other in positive or negative spirals and measure overall ecosystem vitality:

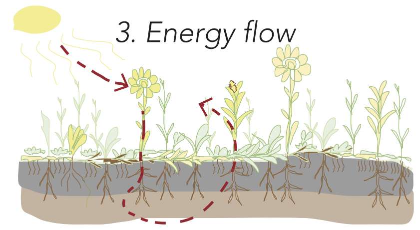
1. **The mineral cycle**
   How well is carbon, nitrogen and other minerals being cycled, producing healthy topsoil?
2. **The water cycle**
   How well is water captured and stored in soil to be accessed by plants?
3. **Energy flow**
   How much energy is produced by photosyntesis and cycled for all other life?
4. **Community dynamics**
   How well are the synergetic relationships thriving of the biological communities in the ecosystem?

(Savory Institute, 2020)

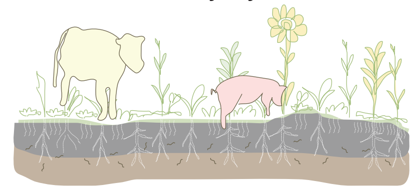
*2. The water cycle*



*3. Energy flow*



*3. Community dynamics*



### More photosyntesis - more soil creation

As a conclusion the more photosyntesis (*energy flow)* the more soil carbon can be produced by plants (improving the *mineral cycle*) and the more water can be stored in the soil (improving the *water cycle*), and all this is aided by a rich diversity in the communities of flora and fauna (*community dynamics*).

In summary nature works in upwards or downward spirals in relation to these processes, either regenerating soil, water & nutrient cycles or biodiversity or the negative spirals of degenerating them that we see today (ibid; Avis et al, 2021).

### Testing questions:

When knowing about these four ecosystem process and having defined your holistic context you can use the HM framework's "testing questions" to determine if all major decisions will either lead you closer to or further away from your context and the regeneration of these ecosystem processes.

# 2.2. Regional food systems

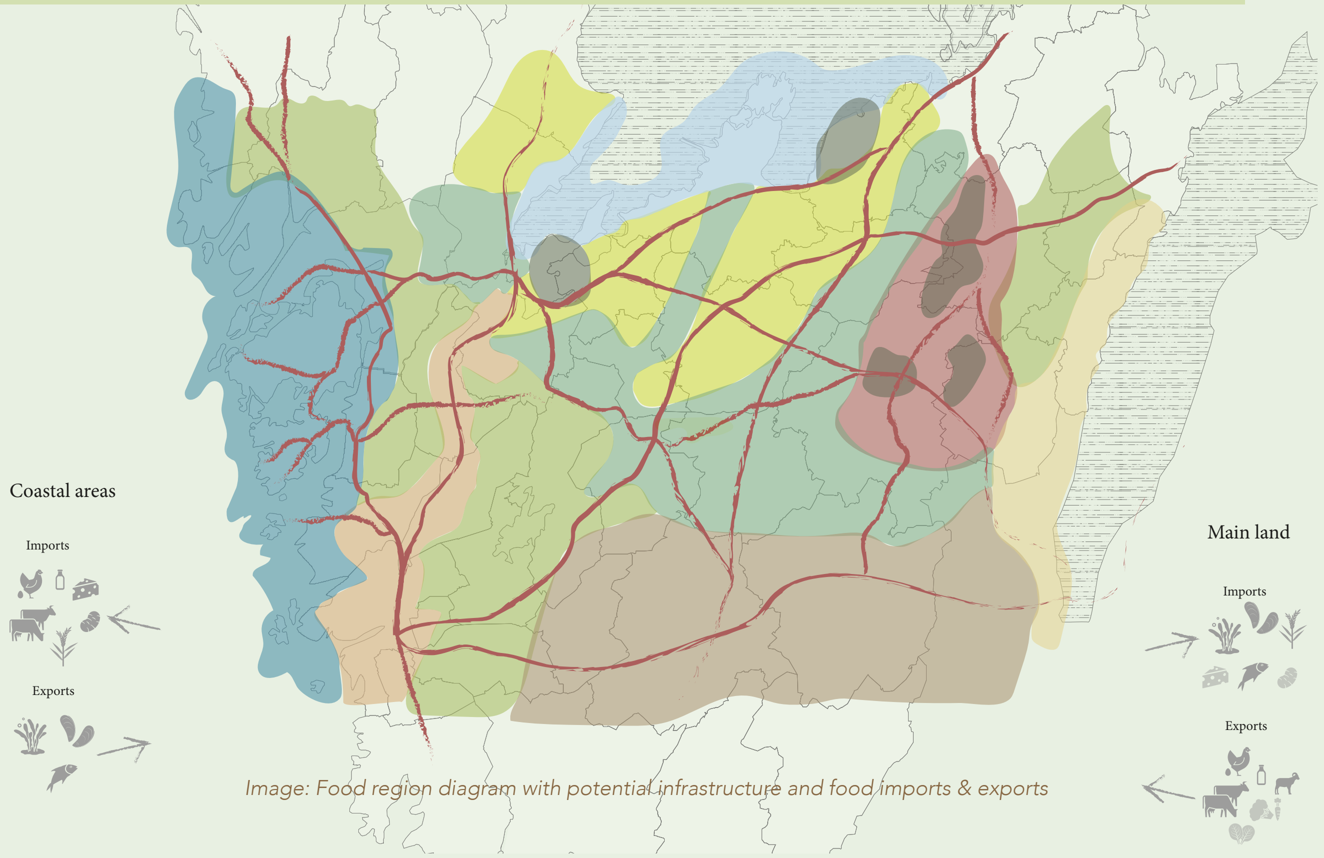



*Image: Food region diagram with potential infrastructure and food imports & exports*

## 2.2.1. What is a region?

### *Different types of regions*

**Administrative & functional regions** - Regions are often defined by administrative boundaries as in the case of Västra Götalandsregionen. Functional regions on the other hand are defined by work markets and commuting routes - travels to and from work (Henning, 2021)

**Bioregionalism** - A bioregion is a "specific geographic area that is distinct from others by the characteristics of its natural environment" (Bove, 2021. paragraph 9) stretching over several interconnected ecosystems (ibid). Bioregionalism often exemplifies this as a region's *watersheds* ("vattenuppsamlings-områden" in Swedish) - limited by water dividing ridges mentioned in the Keyline chapter - which is the complete area that harvests water for larger water bodies.

**Food regions** - Many regions struggle with defining what is local food, how many food miles can we allow for the food to be considered local. Perhaps it is all about having a close relation to the food and I believe "food regions" and "local food" can be defined in different scales by setting some boundaries such as distance, relationship with the farmer etc.

### *What is a food system?*

Food systems defined by FAO (2021) is a part of the "agrifood system" The food system includes "production, storage, aggregation, post-harvest handling, transport, processing, distribution, marketing, disposal and consumption of food" (ibid). FAO states in their 2021 report the importance of "resilient agrifood systems" - meaning to have a robust capacity to handle stress or disruption events and ensure *food security* and nutrition for all people. On the next spread (p. 28) we will dive more into this issue.



## 2.2.2. Defining a food region

### *Food zone defined by landscape geology?*

#### How do you define a food region?

I have taken inspiration from how Trafikverket (2015) identifies the main types of geological land conditions in the region of Västra Götaland. These very much influence our ability to grow different types of food here and I personally use them as a basis for defining larger food regions.

I believe these geological regions will likely specialize in certain foods. F.ex. ocean farming in the case of "Bohus coast", field crop farming in the case of the "Open plains" of Skara, Grästorp and Dalboslätten and the Mosaik landscape will likely have more grazing animals.

- Mountain and Hill - Food zones
- Falbygden Hill - Food zone
- Mosaik Agroforestry landscape - Kedum-Herrljunga-Slättsjö
- Open Plains - Food zones - Skaraslätten, Grästorp- & Dalboslätten
- Small Rift valley & Lake - Food zones - Bohuslän & Gothenburg inland
- Big rift valleys - Food zone - Borås- Ulricehamn
- Göta Älv food zone
- Lake Vättern Coast Ridge - Food zone
- Lake Vänern Coast Food zone
- Bohus Coast Sea Farming zone

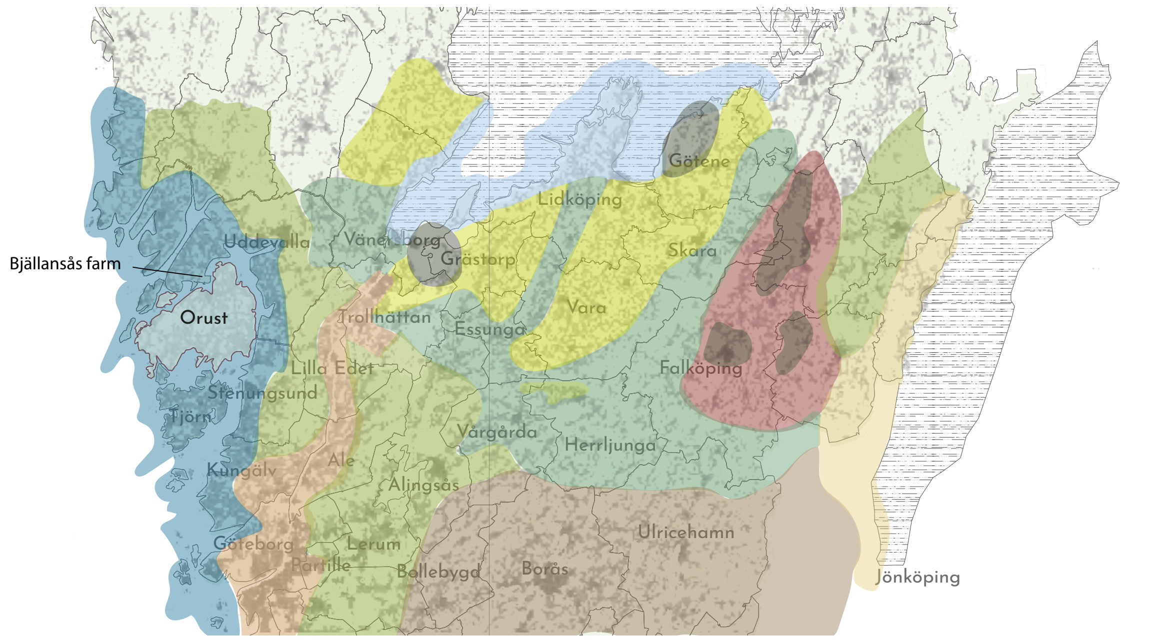
#### Local food at what scale?

My exploration around carbon positive food regions will be closely related to determining the scale to which the food region is defined and it will largely be based on how we can access and distribute food as locally as possible in a carbon positive region. Thus it will be closely related to the scenario of a carbon positive region and what it entails for the food system at large. I believe this regenerative food system requires a more localized food production, distribution and consumption and thus I believe most of the food will originate from a smaller geographical region.

However believe many foods will be distributed in a bigger regional scale. For example algea and mussels grown in coastal areas might be an important feed for animals such as chickens and laying hens in the mainland and even though this chicken is produced very close to consumer its' feed needs to be transported from the seaside across the whole Västra Götaland region. But these transports need to be limited due to the big energy consumption of transports leading to $CO_2$ emissions or consumption of valuable electricity.

In this project I will thus not explore the larger geological food regions but I will be using a definition of a "*micro food region*" that is limited to smaller geographical administrative and physical borders. My case study of a micro food region is the municipality of Orust - also being a complete watershed as it is an island.

*Image: Food region plan 1: 600 000 inspired by geological land types*



## 2.2.3. Food sovereignty

*Having more than enough & the power to influence the food system!*

### Food self-reliance

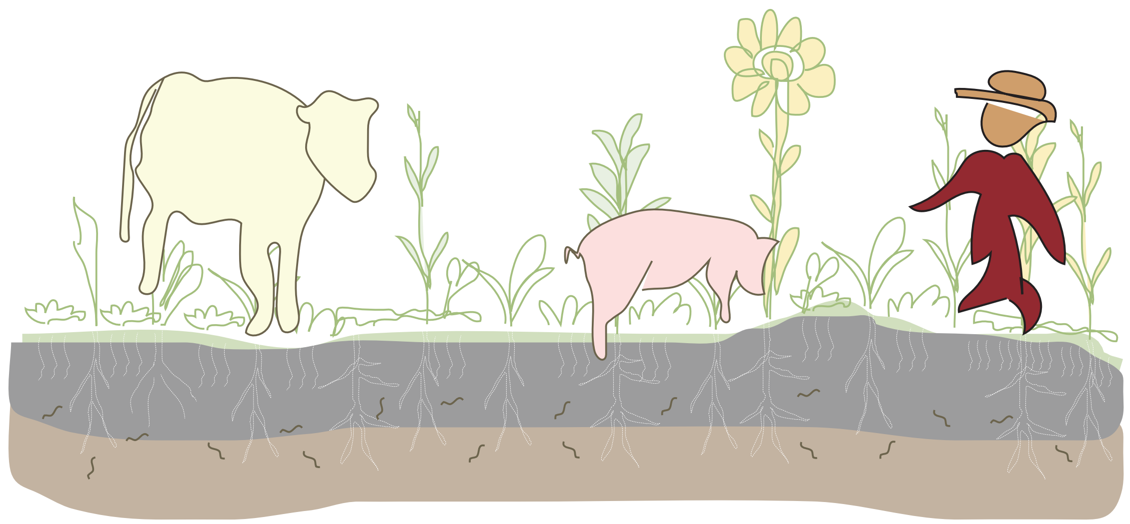
What do I mean with food self reliance and why is it important? As the term of being "100% self sufficient" is not always that realistic and has been used without really understand it's definition I believe it is important to bring some nuance into this term. What I mean when I talk about self reliance it can be understood in two ways - it's about having just surviving or abundance. Using these terms we can understand it's nuances:

- *Food Security (having enough to survive)*
- *Food Abundance (having more than enough and sharing the surplus)*

However both terms are somewhat limited I believe a central thing is for the community to have insight into and control over their local food system. Having a strong relationship with the farmer rather than having the food system controlled by multinational corporations is what we want to achieve. In this regard the overall aim is to gain "food sovereignty", while also achieving both food abundance and food security.

### Food Sovereignty

Food sovereignty is the right of all inhabitants to have access to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agricultural systems. (Nyéléni, 2007)



### Now let's zoom out a bit more!

*So now that we have learned about how we can design farms and regions to build topsoil and regenerate ecosystems, now let's have a look at the bigger picture. How can we achieve a "carbon positive food region" and what does it entail? What is a food region and what is carbon positive? On the next pages we will define these terms.*

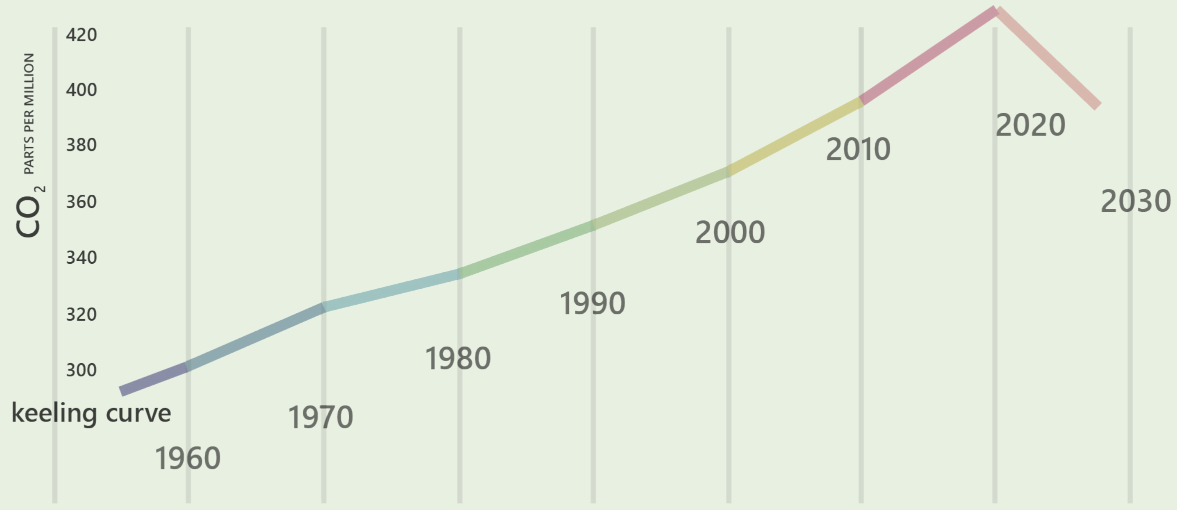


## 2.3. Carbon positive

*Reversing climate change through carbon drawdown*

**We now live in the "decisive decade for the future of humanity"** according to Johan Rockström (2021, last paragraph).
The actions we take until 2030 will impact tens of thousands of years to come in terms of the climate on this planet.

**Achieving carbon drawdown**
In just one generation we could already start seeing cooling and reversal of global warming according to Paul Hawken. (Tickel, 2020)




Potential drawdown as the curve of atmospheric carbon start declining in 2020'ies. This is not just possible but it needs to happen, Hawken and others argue (Tickel, 2020).
Graph: Chen, 2021. [Based on curve from film Kiss the Ground (ibid)].

### Great urgency for carbon drawdown

According to Paul Hawken (2017) we need to achieve "*drawdown*" - the future point in time when levels of greenhouse gases in the atmosphere stop climbing and start to steadily decline. He claims "Drawdown" is "the only goal that makes sense for humanity, anything else is climate chaos". (Tickel, 2020) He argues we cannot mitigate climate change and achieve drawdown of carbon without using regenerative agriculture/ carbon farming and other methods of "*carbon sequestration*" (ibid). Regenerative agriculture on land and algea farming in the ocean are given as examples of the most cost efficient ways to achieve drawdown (Hawken, 2017).

# 2.3.1. Carbon sequestration in farming

## *What is carbon sequestration & carbon farming?*

The previously mentioned five principles of soil health (explained on p.20) and the four ecosystem processes used in Holistic management (p.24-25) provides a foundation for understanding what we can do to capture more carbon into the soil and build healthy topsoil. This process of capturing carbon from the atmosphere through photosynthesis via living plants through their roots into a stable form in our soil is promising. However it is debated how stable the carbon is in the soil actually is - and more research and measurements need to made over time to monitor this. The various practices and rates at which carbon can be sequestered into our soils and remain there over time has been layed out in the book *The Carbon Farming Solution* by Eric Toensmeier (2016). Here Toensmeier argues that Agroforestry systems like Silvopasture (with animals integrated into forestry) are the most promising with potentials to sequester up to 5-10 tonnes carbon / hectare (per year) - and in some cases 20 tonnes / ha per year in a global context. But as numbers are higher in tropical climates it makes sense to find European and Swedish research.

### Potential sequestration - European and Swedish reserch

Toensmeier claims that the average sequestration rates enabled (even in a temperate climate like Europe or the US) by converting conventional crop land to agroforestry or converting pasture to silvopasture (integrating trees on pasture) would sequester around 3 ton carbon /ha /year. Each ton of carbon means 3,67 tons of CO2 wo this means around 11 tons $CO_2$ /ha /y.

However many academic researchers are more cautious and professor in Systems ecology Tomas Kätterer (2022) as well as the authors of a meta-study by European scientists (EASAC, 2022) both refer to sequestration rates around 2,8-3,67 tons $CO_2$ /ha /year demonstrated in studies where previouosly plowed fields have been transformed to grassland or left to themselves over some years. As this is not an actively regenerative land use but more passive sustainable land us in my mind I argue higher numbers shall be possible.

According to Australian soil scientist Christine Jones (Schwartz, 2013), most of our current ways to measure carbon sequestration disregard the great potential to store carbon in the deeper layers of the soil as it is often measured only in the top 30 cm and she argues that through the liquid carbon pathway plants can send about 30-40% of their carbon to microbes which directly forms humus in the soil and she argues for rates around 5-20 tons of $CO^2$ per ha/year (ibid). As a conclusion I believe that somewhere between 3-11 tons $CO^2$ per ha shall be feasible to strive towards tools like EOV-monitoring (explained in chapter 3.4) and more research shall be used to confirm such rates.

> *”Under appropriate conditions 30-40% of carbon fixed in green leaves can be transfered to soil and rapidly humidified resulting in rates of soil carbon sequestration in the order of 5-20 tons of $CO_2$ per ha / year.”*
>
> **Dr. Christine Jones** - *Australian soil scientist*
>
> (Schwartz, 2013, 2 h 13 min)



# 2.3.2. Zero or negative emissions

## *From carbon negative to carbon positive*

### Net zero - but what emissions ”count”?

Even as the emissions produced in Sweden has decreased over time - emissions from products consumed in Sweden but produced in other countries have increased by almost 50 percent over the past 20 years. according to SCB (Naturvårdsverket, 2021). Emissions from private consumption accounts for about 2/3 of Sweden's consumption-based emissions (ibid).

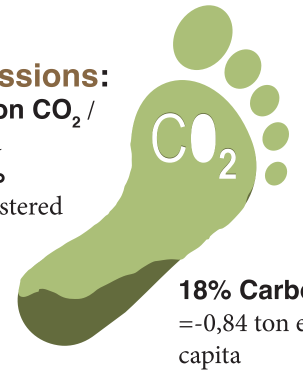
In order to fulfill Sweden's commitment to the Paris Agreement, the government has set goals to reduce our climate emissions. What it means is that Sweden need to reduce consumption-based climate emissions from 9 tonnes per person per year to 1 tonne by 2030. (NVV, 2021)

As the first region in Sweden (maybe even globally), in 2015, Västra Götaland's goal for consumption based greenhouse gas emissions, regardless of where in the world they take place, is to decrease them by 50% until 2030 - and reach net zero emissions until 2045. (VGR et al, 2022). But is this really enough if we need to reduce emissions by 90% to go from 9 tons to 1 tons per capita as a nation until 2030?

### Becoming carbon positive - not just neutral

We probably need to start asking: Can we sequester carbon to mitigate all our emissions, leading to *net zero* emissions or even *net carbon sequestration* - even if all consumption based emissions are included? If we set goals to get to 1 ton net emissions or even 0 tons per capita how many hectares of farmland do we need to regenerate by increasing soil organic carbon? This will be further explored in chapter 3 and 4.

**Emissions:**
**4,5 ton $CO_2$** /
capita
**118%**
sequestered




**18% Carbon positive**
=-0,84 ton emissions /
capita

*Image of potential sequestration in Orust in Scenario B. Read more in chapter 3.3.*

### Current emissions

Below are the current emissions in Västra Götaland County (VGR) & Orust municipality which gives an idea of the need for both emissioon reductions and carbon sequestration. If we manage to half our consumption emissions to 4,5 tons/capita to 2030 the remaining emissions will have to be negated through carbon sequestration to reach net zero.

### Defining Carbon positive

The term ”Carbon positive” was coined by William McDonough (2016) in his Nature article ”Carbon is not the enemy”. His ”new language of carbon” defines *carbon negative* as pollution of carbon and *carbon positive* as a net sequestration - when our sequestration is higher than our emissions of carbon. This is the way to achieve carbon drawdown. But what emissions count? I argue we need to to include all consumption emissions.

| | **Territorial emissions:** | **Consumption based emissions*** |
|---|---|---|
| VGR = | 9.8 million tonnes | 15,7 million tonnes (1,74 M. inh.**) |
| Orust | 59 000 tonnes | 135 000 tonnes (15 000 inh.**) |
| | (SMHI, 2019) | *based on 9 tons/capita and populations of 2022 |
| | | **(SCB, Dec 2021) |

# 2.4. Food System Design

## *What is food system design?*

### It's time to design our food systems

We design and plan our cities and regional infrastructure like roads, housing areas, water pipes etc – so perhaps we shall also collaboratively desing our food system. But how do we design and plan our landscapes to facilitate regenerative land use and food production? What role does physical planners have and how can we encourage bottom up initiatives led by farmers, land owners and consumers?

### Planners play a key role but so do all "eaters"

Based on varioius interviews I understand that a big challenge is not to create more damage than good with tools of top down planning (as is often the case with bureaucracy, regulations, etc, often hindering grass root movements of small scale regenerative agriculture). By finding a good balance of bottom up and top down initiatives this might be achieved.

When we consider the role of all eaters we realize that planners have a limited impact. As consumers daily eating habits will be a very big driver of our global and local land use as well - it is time to join hands and start a collaborative design of our food systems based on both comprehensive land use planning and relationships between land stewards (farmers) and the people supporting them through buying their food (eaters).

## *Shaping our landscapes with every meal*

### Co-creating our future food systems

How would we like our landscapes, ecosystems, communities and future resource base to look not just for all humans today and in the future, but for the benefit of all living beings?

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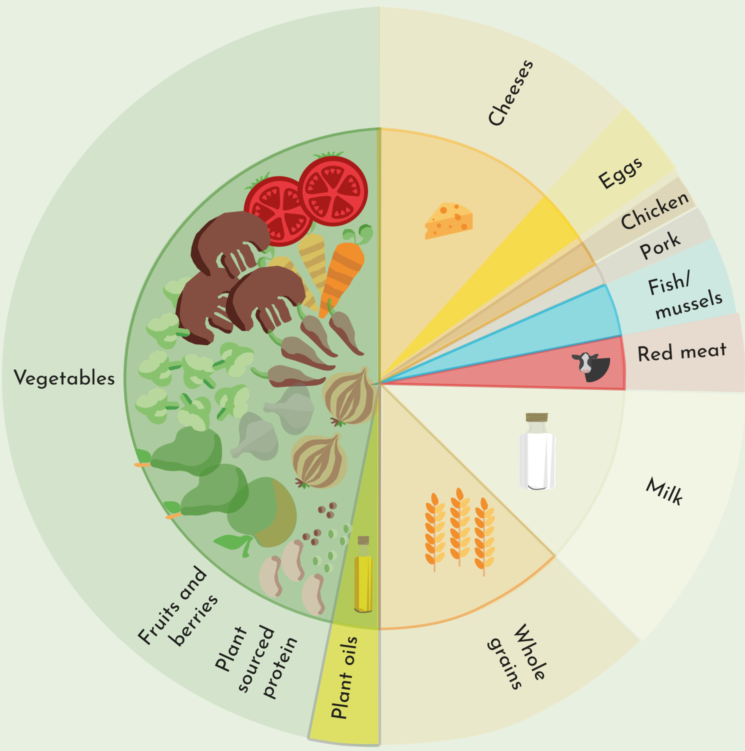





# 2.4.1. Positive "Foodprints"

## *How what we eat shapes the landscapes around us*

### What if we could design landscapes by the very act of eating?

This is what I call "Positive Foodprints"! Designing our food system can be done by making more conscious acts of eating and having a closer relation to the land and the farmer who manages it – step by step shifting the outcome of that management to land regeneration!

### Positive and negative "foodprints"

*The daily choices of what people eat, could itself be seen as an act of "food system design" – impacting our common landscapes for the better or for worse.*

*By voting with our forks and supporting regenerative farming we can create "Positive Foodprints". This is how we collaborative design our food system.*

### We are all land stewards if we eat food

Land use is no longer just a consequence of global corporations domination of food chains and the market economy's forces for urban sprawl, building houses on farmland etc. Planners play an important role here but we must realize that consumers may in fact have more impact in terms of shaping the markets "invisible hand" and taking back the control of our food systems by building relationships with their local farmers.

### Let's unite in our food regions with a common vision

It's time to realize that we all affect the land and ecosystems of the planet and start to form an alliance between farmers, consumers and planners (public authorities) in shaping our own holistic context of what we want our land use to be like in the future for all species to thrive on this planet, including current and future generations.

## 2.4.2. The Regeneratarian diet

### *What we eat in the future - beyond the EAT Lancet*

#### The sustainable vs. regenerative diet

In 2019 the EAT foundation launched a global guide for how we shall all eat to reach climate goals, be healthier etc. However the diet has been criticized for its ina bility to provide enough protein in attempts to limit meat consumption alternative proteins may not be sufficient.

In light of the much needed paradigm shift from Sustainable to Regenerative the diet can also be seen as trapped in doing less bad. Together with many regenerative farmers and eaters, I argue that we shall not just decreases bad impact of meat but increases good impact by eating regenerative animal products as mentioned in the film and book Kiss the ground (Tickel, 2017 & 2020).

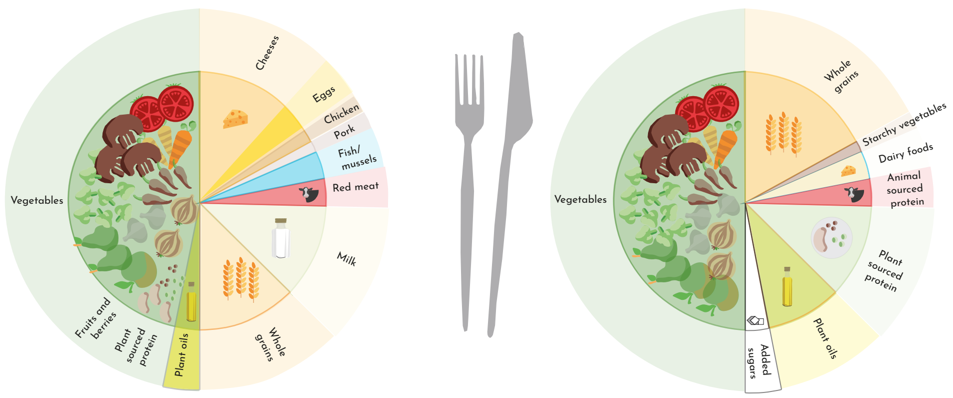
#### Criticism of the EAT Lancet and the "sustainable diet":

EAT Lancet (2019) and their recommendations for a healthy sustainable more plant centered diet. In a podcast interview Nina Teicholz, an american science journalist specialised in nutrition, explains how the way we view meat and animal fats and proteins as unhealthy is due mainly to strong economic and political interest in keeping this paradigm (Maquez & Morgan, 2021). She also reviews the EAT Lancet in light of the panel behind it having political/economic interests in veganism, including companies like Beyond Meat (selling meat substitutes) and and very much criticized Monsanto (selling pesticides like glophosate and GMO crops resistant to such chemicals). Nina Teicholz explains it is also based on a health paradigm which science has failed to prove, namely that all animal products and saturated fats are bad (Maquez & Morgan, 2021). It also fails to deliver on protein needs of people and means we eat very little meat, eggs and dairy (ibid, 2021). Back to Monsanto's pesticides: Do you remember we might go excinct as a species in 70 years? The main reason why is actually the chemical *glophosate*, declared by Dr. Zach Bush as "public enemy number one" (Kempf, 2021. 18 min) - in fact it is present in our drinking water globally above the threshold levels which affects human and non human life and reach over 100-1000 times these levels in sprayed vegetables and animal feed (ibid).

#### What does a regeneratian diet look like?

So what shall we eat then to minimize chemicals and build up the soil. Well both plants and meat from regenerative farmers obviously! The plate models below left are comparing these two diets. To the right is the regeneratarian diet, an adaptation of the EAT Lancet to include more healthy meat and animal products from regenerative farms shown in science to support health (ibid) and sometimes even capturing more carbon according to an LCA of the Carbon footprint of White oaks pasture regenerative meat (Quantis, 2019).

Image reference:
Further developed
from image by
Emelie Stenhammar

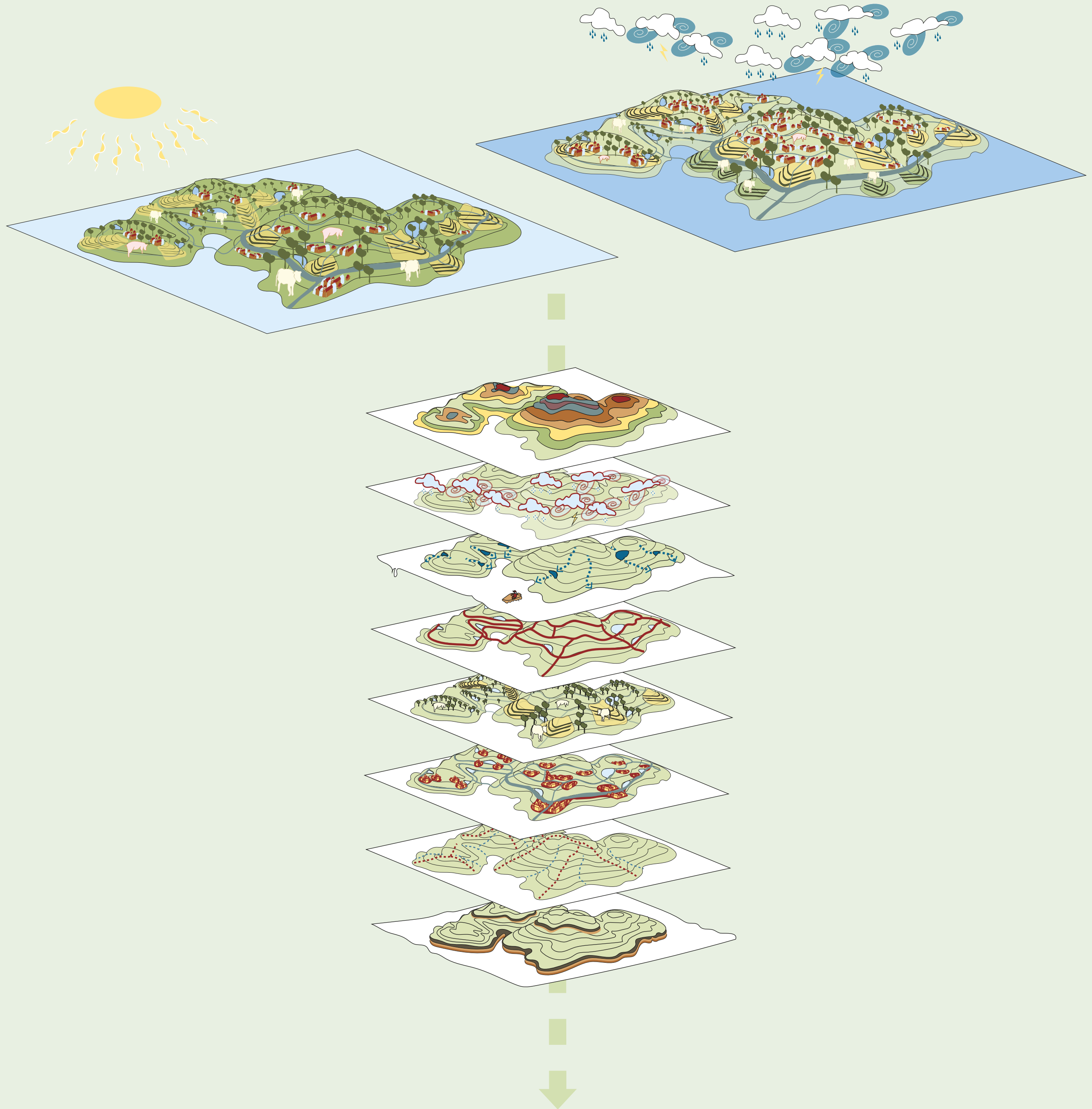



Regeneratarian Diet

EAT Lancet diet



# 3. Design

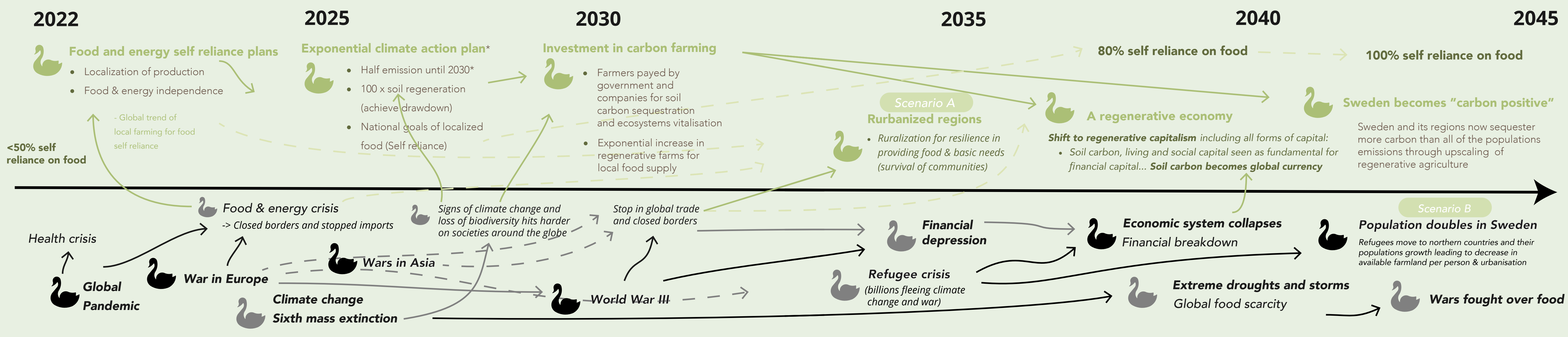


# 3.1. Regional futures

*The decade that would make or break human civilization was a bumpy ride!*

# 3.1.1. Future Scenarios 2030

*How wars, pandemics, climate change and ecosystem collapse influenced us*

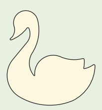



*Black and green swans of exponential change*

The 2020-ies has been called the "*make or break decade*" or the "*decisive decade*" . Could we achieve drawdown of carbon and reverse global warming and the sixth mass extinction of species - while also facing global pandemics and a new world war? In my two scenarios explored this was just what we needed to actually make the exponential changes fast enough to avoid passing irreversible tipping points of climate chaos for millennia. The "black swans" of social, ecological and economic crisis events triggered many "green swans" to grow resulting in exponential growth of initiatives around regeneration (Elkington, 2021).



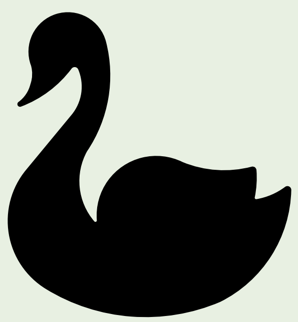
**White Swans**
are still blank pages, that can become either green or black swans.



**Ugly ducklings**
are often not seen as potential exponential changemakers until they grow up

## The Green Swans of the 2020-ies

These are the exponential regenerative transitions (positive spirals) we made that saved us and the future of human civilisation from collapse. These rapid changes affected all dimensions of sustainability positively, regenerating ecosystem, social and economic systems. Many of them came from black swans (below) or white swans and ugly ducklings, emerging swans that could either become black or green.



## The Black Swans of the 2020-ies

These are the exponential degenerative transitions (negative spirals) like world wars and unexpected events like pandemics that affected some if not all dimensions of sustainability negatively. Even if these events were predictable (called grey swans) the impact was so big no one could have predicted it, just like when Russia invaded Ukraine 24 feb 2022, forever changing the history of Europe.

*Theory and definitions from the book Green Swan (Elkington, 2021) and Nicholas Taleb (2015).*

# 3.1.2. Regional land use, 2045

## *Land use shifts to feed a growing population*

### Exploring two scenarios

After comparing two scenarios of population change and its impacts on the region, I conclude that they will both be very different from todays land use.

### Scenario A: Rurbanization & decentralization

The rurbanized scenario in 2045 (A) is where Swedens population increased on 15 million inhabitants (about 50% increase) but with a rurbanization of the more sparsely populated regions of Sweden, with more equal distribution across the Västra Götaland region (VGR) and only an influx of about 500 000 inhabitants means the population in VGR has increased with 31% to about 2,3 million inhabitants.

As Swedens inhabitants have only increased slightly due to climate refugees and the nation is now self reliant and can even export 50% of our food. VGR is self sufficient but has no extensive export, maybe even importing some meat from northern Sweden and exporting some seafood etc.

### Scenario B: Urbanization and growth

In this urbanized scenario in 2045 Sweden & Västra Götalands population has doubled to 3,6 million residents in VGR and 22,5 million inhabitants in Sweden can barely feed its inhabitants if they eat as much meat as today. Big cities rely heavily on imports and the Northern Sweden exports food to Southern Sweden. Västra Götaland could become self reliant only when the inhabitants started consuming less meat (expecially from pigs and chicken), reducing our consumption to 36 kg meat per person per year and feeding the non ruminant animals (pigs/birds who don't eat grass) with 75% food waste and 25% algea/mussels.

With 22,5 million inhabitants we have 1,75 ha per capita total land (of which 0,1 ha of farmland, 1,25 ha forest and 0,35 ha grazing). If we shift land use to what you see below here most of the forest is transformed into forest farming and agroforestry where pigs, goats and grazing animals can be introduced in a mosaik landscape.

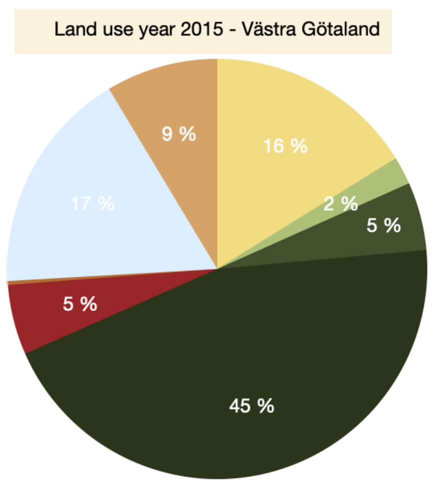



Diagram 1a:
**Land use today**

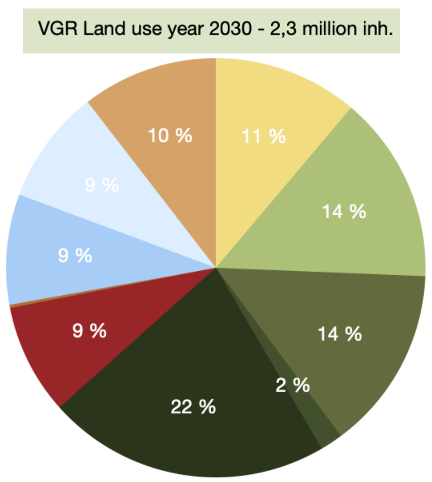



Diagram 2a:
**Scenario A**

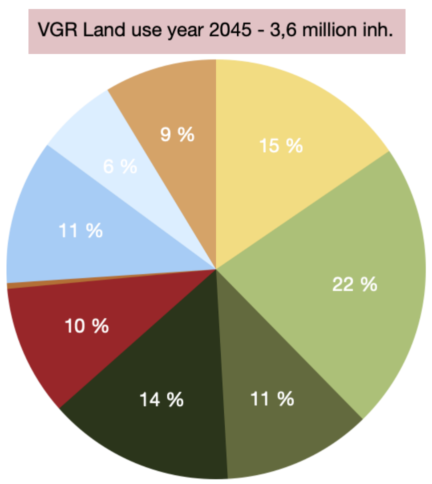



Diagram 3a:
**Scenario B**



# 3.1.2. Farmable land per capita

## *How much land is needed to feed the region?*

### Massive shifts in land use to feed a growing population

In order to feed the growing population of Västra Götaland, with both climate and war refugees from all over the world, land use in both scenarios has shifted dramatically. From 17% farmland and 50% forestry (in 2015) to about 40-48% farmland and 14-24% forestry (2045). This also means the built area cannot increase more than to 8-10% from todays 5% primary being situated on mountains or existing built areas (buildings/roads).

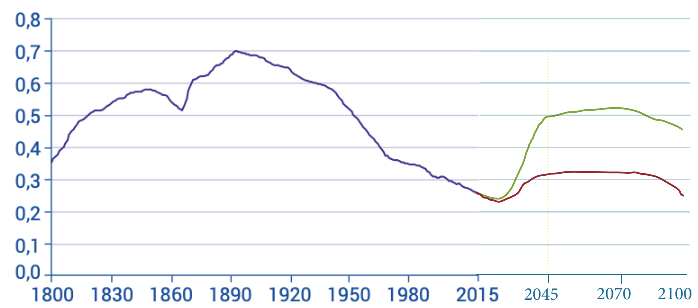
### Is there enough land to feed people within the region?

The land use presented above would give each inhabitant 0,5 ha of farmland if there is 2,3 million inhabitants (*Scenario A* - diagram 2a & 2b). At 3,6 million inhabitants that number is 0,32 ha/ inhabitant (*Scenario B* - diagram 3a & 3b). The previous land use percentages (diagram 1a & 1b) would only give us 2292 sqm/ inhabitants in Scenario A and 1464 sqm / person in Scenario B with a doubled population.

**Sweden has a historically low share of farm land per capita today** due to farms closing while population rises. In 2015, arable land per capita was only 0.26 hectares. At it's peak it was at 0,70 ha / person in 1893.

*May we come back to levels like that in the future? Will populations increase further beyond 2045 pushing us to use even more farm land leading to peaks in farmland/capita?*

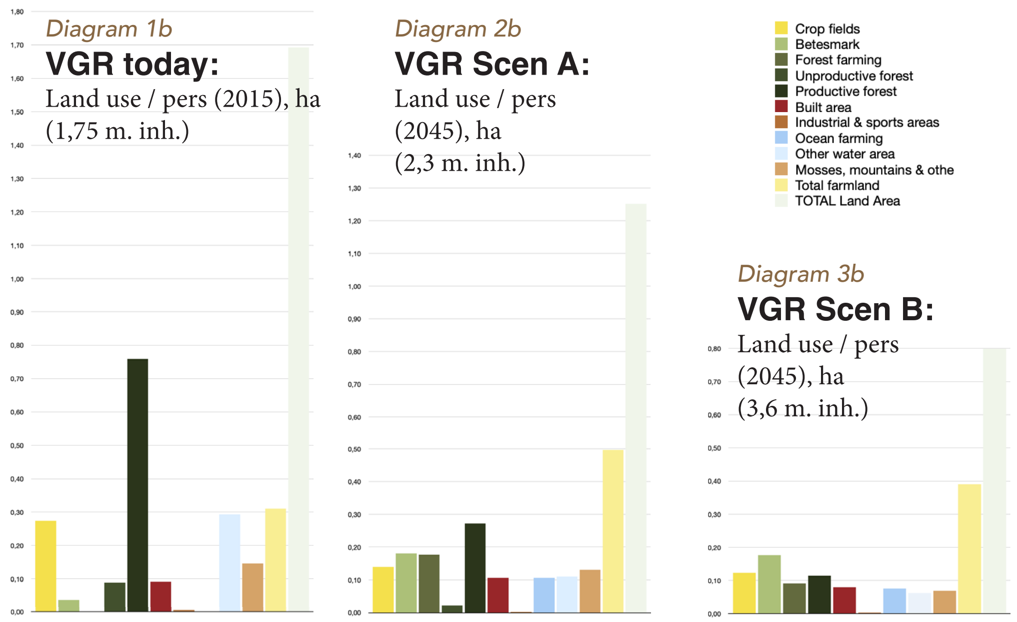
**Diagram 4**
Farmland per person 1800-2015-2100, hectares




Graph: Jordbruksverket & SCB, 2015 bearbetning SCB (2019).
Future curve: Me.

**Farmland per capita**
In the calculations I have made of land needed per inhabitant it goes up to 1,37 ha/person when eating 52 kg meat (20kg red meat, 32 kg pork/chicken) per year and feeding and pigs birds with grains. If these non ruminants are fed mussels/ algea, food waste very little grains its enough with about 0,467 ha/person + 0,131 ha ocean/person.

This means in Scenario B an *urbanized* region with 2x population we need to import 30% of our food, and Scenario A - a *rurbanized* region - we can be 100% self reliant on food making the VG region more resilient to uncertainties and black swans.




### A summary of the land use shifts

From 17% to 40-48% farmland, integrating animals in the forest and using 240-270 thousand hectares of our ocean for farming algea and mussels.

# 3.1.2. Rurbanized Västra Götaland

*Scenario A:*
*Welcome to a decentralized & "rurbanized" future*

### Several urban cores with farmland integrated

The idea of integrating urban and rural - cities and farmland - has now become the main paradigm of regional "rurban" planning. We do this by having several denser urban cores with a maximum of 30-60 thousand inhabitants surrounded by the farmland to provide for their food needs. We're thus planning for food security and equal opportunities to live in the whole region.

*Based on the 2 scenarios on the previous page I chose to further explore with scenario A - as a more desirable future which is also similar to one scenario created in a regional trend analysis (VGR, 2021).*

### Local food self reliance

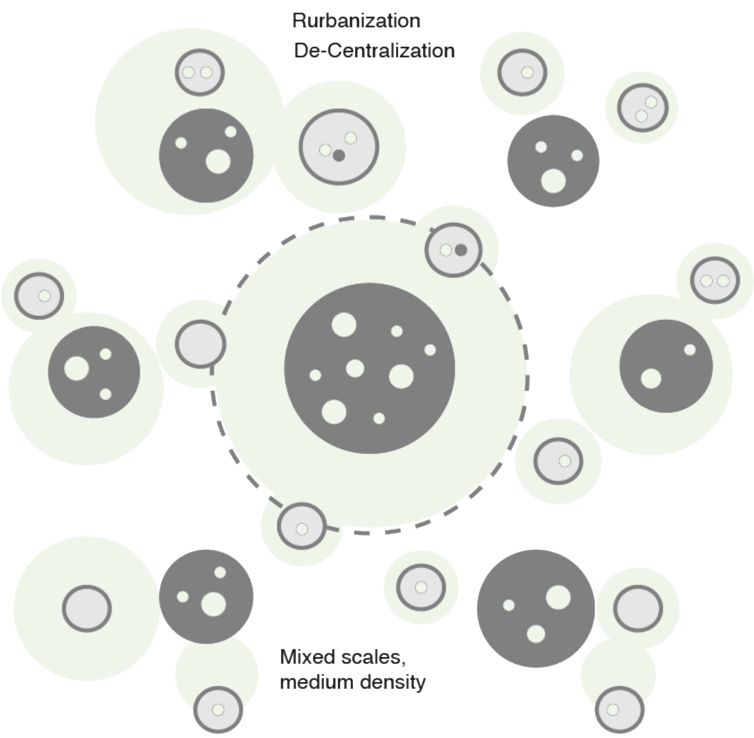
Our self sufficiency rate in Sweden was extremely low in 2021 (less than 50%) whereas today we grow all the food we need even with a population of nearly 15 million inhabitants. In VGR and Sweden we had to increase the amount of land used for agriculture.

This also meant that we had to change the way we use our land. We went from having mostly forest monocultures - a landscape that gave very little habitat, food and carbon sequestration - to a diverse agroforestry landscape producing lots of food (with both grazing animals and edible crops) and a very high carbon sequestration and biodiversity value.

We opened up our forests but also planted tree alleys on our fields so the net carbon sequestration rates could increase even with more agricultural land.

### Diagram: Decentralisation and rurbanisation

Driven by regional planning and bottom up "rurban planning"






# 3.2. Bjällansås farm

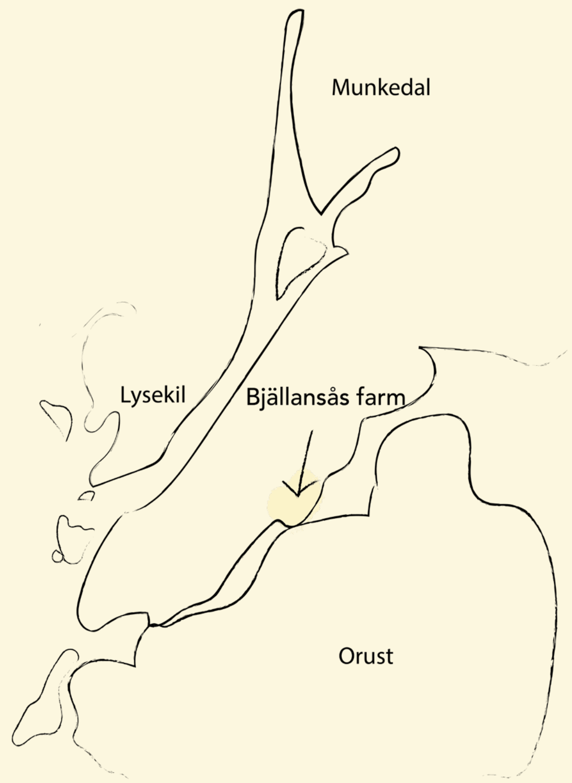
*Let's move into our two contexts to explore what this future scenario means!*

In order to fully understand this scenario and how it affected the region we will move into examples at two scales - my two project contexts:

First, we will explore Bjällansås farm, that in this future became a regional model of regenerative farming.

Secondly, we will move to Orust municipality and see how the whole municipality became more resilient and self reliant on food.

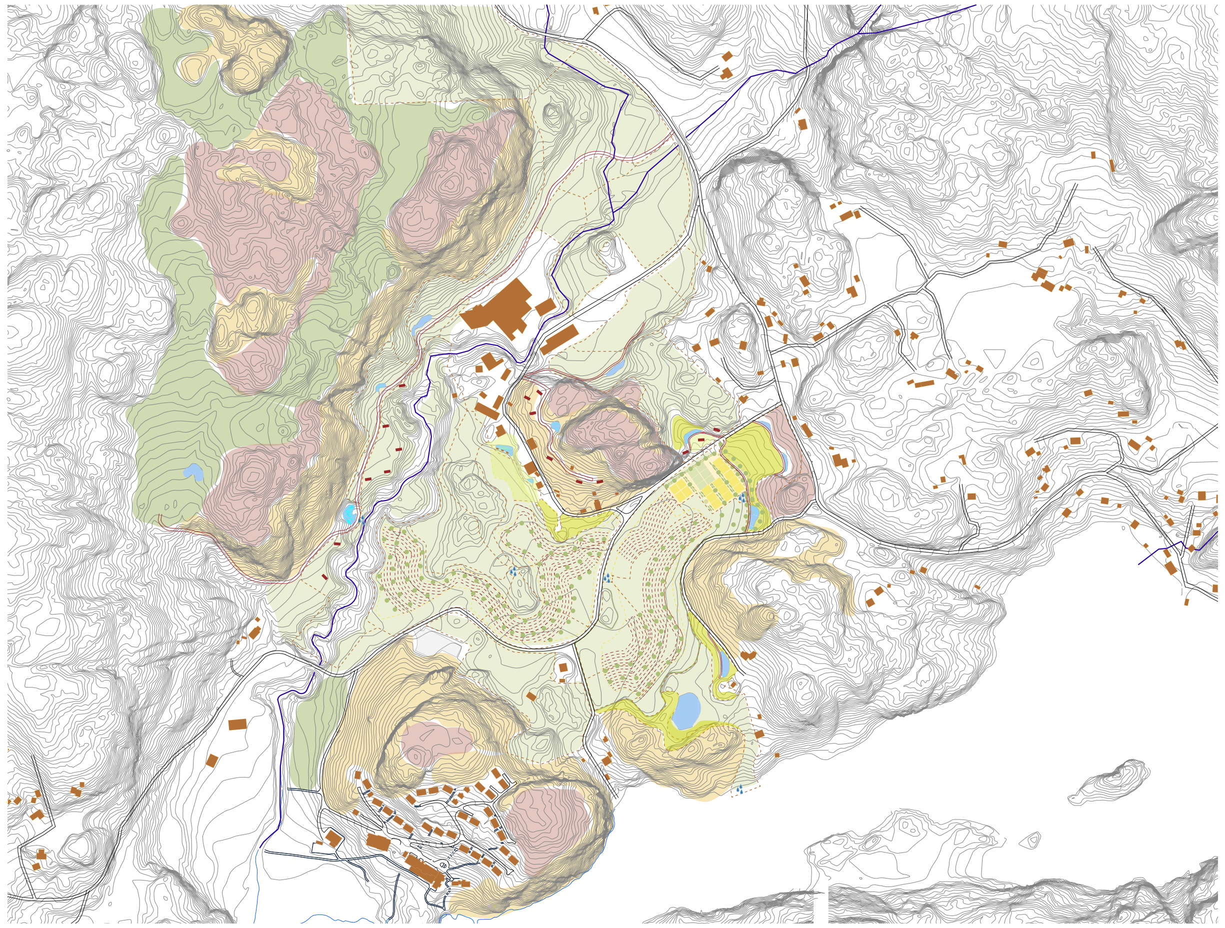
*Bjällansås farm is situated in Uddevalla kommun, just above Orust.*

# 3.2.1. Welcome to Bjällansås in 2045

## *A model farm and educational hub for regenerative agriculture*

Welcome to Bjällansås farm! My name is Emil and I am the fifth generation of farmers here. We are not just a family business but a cooperative that now manages 1000 h of land across Orust, Bokenäset and Lysekil municipalities. We collaboratively manage 1000 cows, 1000 sheep and 500 goats, 5000 hens, 100 forest raised pigs, 1 000 fruit and nut trees and 20 000 berry bushes.. Here you can join courses or do internship to learn everything about regenerative agriculture and start your own carbon farming business. We act as a model farm and our access to market (Gröna gårdar) and land (network of owners) can be used as a springboard for new regenerative farmers to ”try their wings”.



Farm overview - Scale 1:10 000

Goats & pigs on steeper hill areas
Pigs & sheep on ridges
Forest gardens and private gardens
New grazing area for cattle added 2045
Grazing area in 2022 for cattle
Existing gardens
New market gardens
New tiny houses
Existing houses
Fencing
Keyline cultivation patterns Proposed patterns for subsoiling
Silvopasture lanes - with berry bushes between trees
Fruit and nut trees - proposed in meadows
Existing roads - 2022
Wells - Existing water outlets for animals & gardens
Ponds
Stream
New roads - 2045



# 3.2.2. Bjällansås farm today, 2022

## *A pioneer in organic & regenerative agriculture*

Bjällansås is a typical example of a regenerative Swedish farm. But also a special place with very special people that has lead the way for the movement as a whole. As the third generation of farmers and managers of the land, Jan Karlsson, lived on the farm in Bokenäset since he was born here in 1945. He has been a pioneer in organic farming and one of the first to employ organic and KRAV certification and later also went a step further by practicing regenerative agriculture and holistic planned grazing.

As one of the first organic meat producers in the area he faced the challenge that no wholesaler wanted to buy the meat - and so he took it into his own hands and started the company Gröna Gårdar - today selling meat directly from farmer to consumer from 40 farms in the region raising grass-fed animals.

### *S*

**Personal resources**
- Knowledge & Experience in Regenerative Agriculture
- Access to Land, cows and marketplace (Gröna gårdar)

**Microclimates for gardens & trees**
Good microclimate suitable for integrating both gardens, trees and more animals.

### *W*

**Water & feed input + Nutrient inbalance**
- Winter feeding requires of diesel, work, money. Feed and water (pumped from wells) needs to be transported to animals & manure is concentrated on the farm.

**Ownership** of farm and land not clarified, who will take over.

**Risk of people burning out**
- Farm business and ownership depends on few people

### *O*

**Ponds and access roads**
- Build ponds to water gardens and animals & roads for easier access.

**Build more soil carbon!**
- Integrating more animals and trees for more "impact" and sequestration of soil carbon & water infiltration.

**Become a hub for teaching regenerative agriculture**
- A model farm in VGR scaling up regenerative agriculture.

**Be payed for the Carbon sequestration**

### *T*

**Social resilience can be stronger**
- Lack of ways for local community to interact, build trust and social capital

**Potential conflicts** with land owners and local community

**Increasing population due to war / climate refugees** might lead to conflicts of land use for housing and energy, etc.

**Risk for erosion on hills & roads** from storms and extreme weather.

## *The situation today*

Jan owns just abount 10% of the 450 ha they manage. On this land they manage about 600 cows in a way that regenerates the land, builds topsoil and repairs broken ecosystems.

The farm recently employed a new grazing plan manager as Jan can no longer manage it all himself, and they also already employ several other people doing the moving of cows.

# 3.2.3. Bjällansås - Design goals

## *Weakest link and design goals:*

### Weakest link:

**$W_1$ = Geography** *(1)*, **Water** *(3)* **& Roads** *(4)*
- Geography and roads are sensitive to erosion from storms and extreme weather

**$W_2$ = Water & Feed input + Nutrient inbalance (farm animals)** *(5)*
- Winter time lots of feed and water (pumped from wells) needs to be transported to animals. Also lots of manure is concentrated on the farm.

**Personal resources**
*- Lack of ways for local community to interact, build trust and social capital*
*- Farm business and ownership depends on few people*

### Biggest strenght/opportunity:

**$S_1$ = Geography** *(1)* **& Water** *(3)*
- Create ponds to water animals/plants and build dam walls into roads for easier access to hills sides.

**$S_2$ = Climate** *(2)*, **Agroforestry** *(6)*, **Fencing** *(7)*
- Integrate carefully place tree rows and vegetable gardens in sunny wind protected microclimates and adapt fencing to ensure practical management.

**$S_3$ = Water** *(3)*, **Soil** *(8)* **& Animals** *(6)*
- Build more soil and food by integrating more animals for more animal impact, thus improving water infiltration and ecosystem processes.

**Personal resources**
*- Knowledge & Experience in Regenerative Ag*
*- Access to Land, cows and marketplace*

### DESIGN GOALS / STRATEGIES:

**CREATE POSITIVE SPIRALS:**
- Regenerate even more land/ecosystems: Make better use of land, water and sun to produce more food with less work/ money. + Reduce cows water needs + Close all nutrient cycles from animal manure by growing mussels and using it for animal feed.

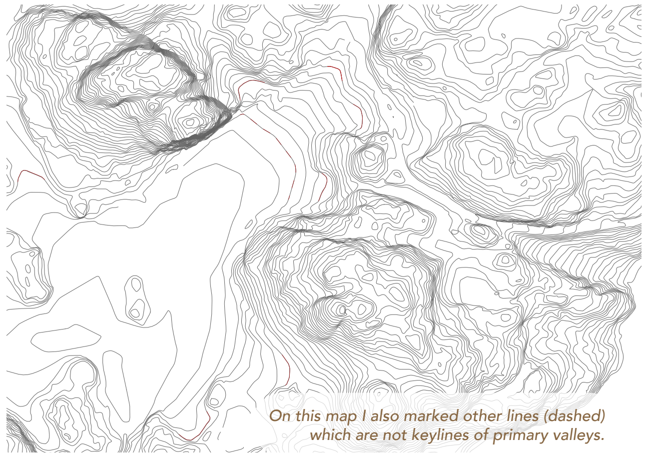
**CAPTURE & STORE ENERGY:**
- Build more soil an capture more carbon through agroforestry tree lanes and more animal impact with a diversity of animals (f.ex. laying hens)

**STRENGHEN SOCIAL CAPITAL:**
1 - Sell food to local community and involve more locals in taking care of animals/gardens.
2 - Allocate land for build tiny houses on the hills to accomodate more people.
3 - Becoming a model farm for regenerative agriculture and start teaching new farmers.

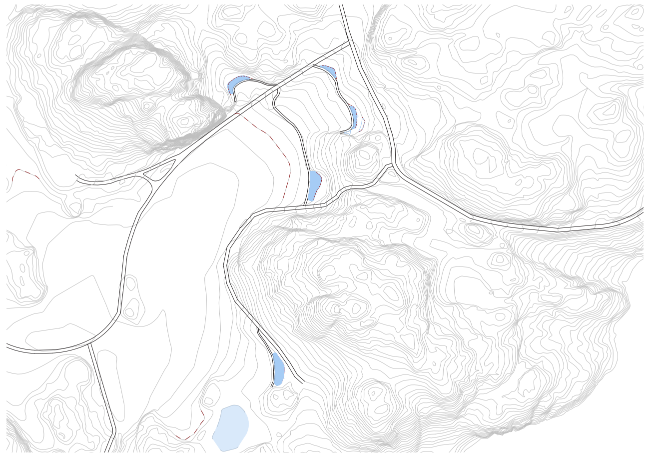


# 3.2.4. Bjällansås - Keyline design process

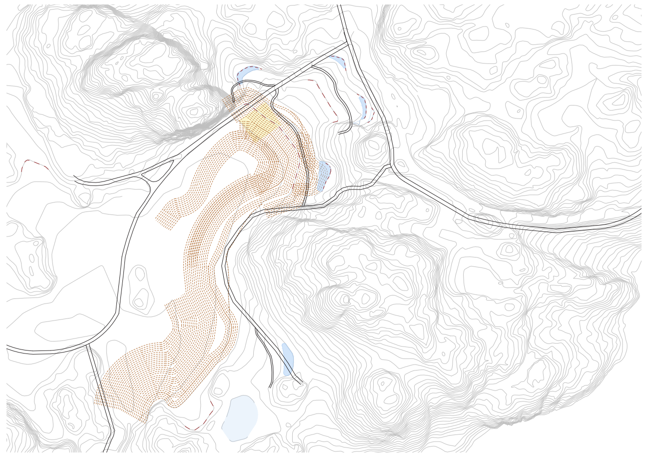
**Step 1 - Geography** (layer 1, in the KSOP)
Understand valleys/ridges and find the keylines in each primary valley.




**Step 2 - Water & Access** (layer 3-4)
Design ponds and roads in suitable places (roads to divert water to keyline ponds)



**Step 3 - Keyline cultivation patterns** (layer 5)
Cultivation patterns that move water from wet valleys to dry ridges while also allowing roots to penetrate deeper.



**Step 4 - Silvopasture lanes** (layer 5)
Design tree rows along these patterns with 16-18 meters apart. Existing houses seen in brown (layer 6).


**Step 5 - Market gardens** (layer 5)
Placement of vegetable gardens in most sunny areas, beds following cultivation patterns where possible.

**Evaluation - Sun study** (layer 2)

# 3.2.5. Bjällansås - Design overview

## *SWOT analysis summary*

***$W_1$* = Water** *(3)* **& Roads** *(4)*
- Roads are sensitive to erosion

***$W_2$* = Nutrient inbalance (farm animals)**
- Lots of manure is concentrated on the farm.

***$S_1$* = Geography** *(1)*, **Water** *(3)* **& Roads** *(4)*
- Create keyline ponds and water catching roads.

***$S_2$* = Climate** *(2)*, **Agroforestry** *(6)*, **Fencing** *(7)*
- Integrate vegetable gardens and trees with grazing.

***$S_3$* = Water** *(3)*, **Soil** *(8)* **& Animals** *(6)*
- Build more soil and food with more animal impact.

## *Key interventions*

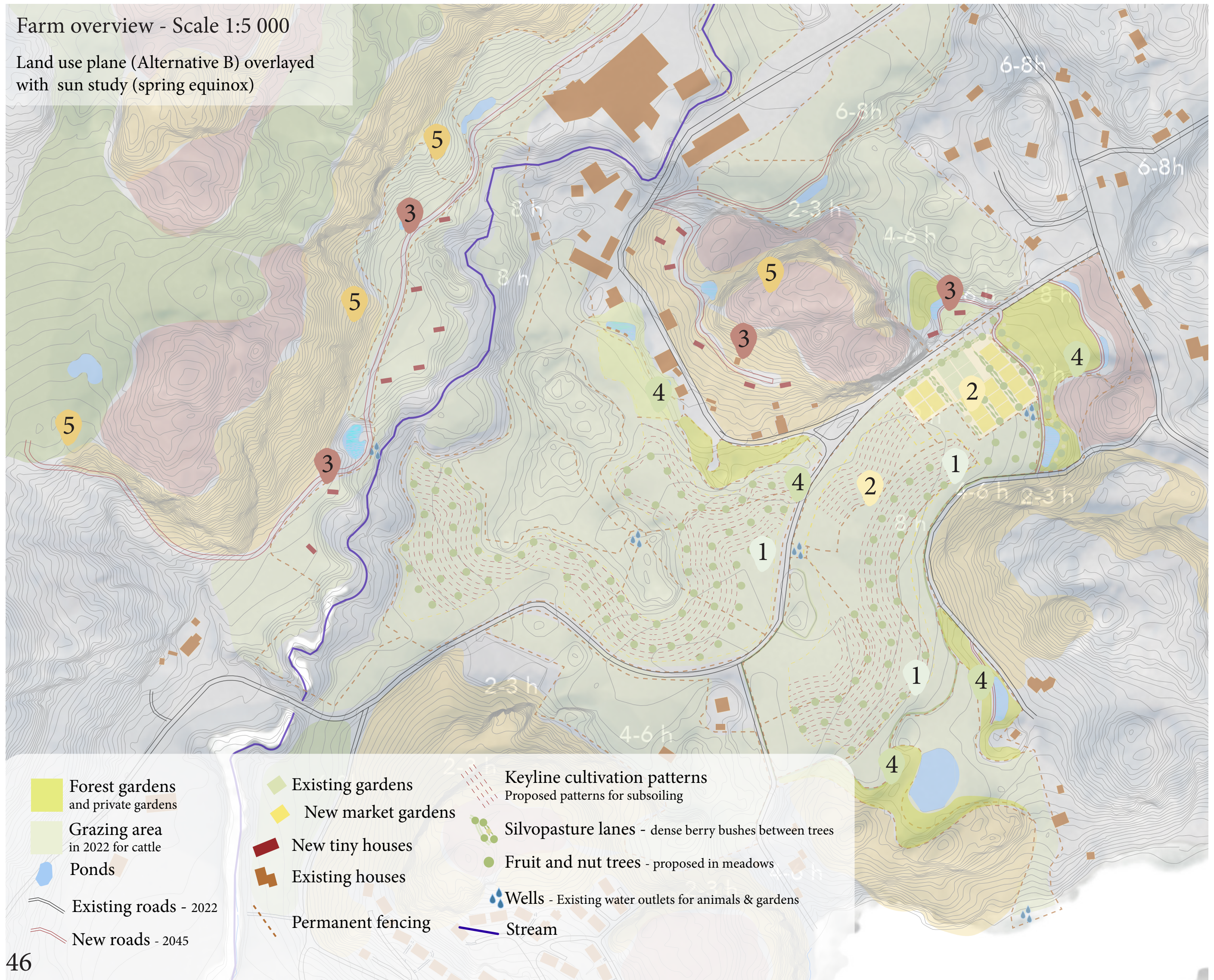
***1.*** Integrate tree lanes & poultry on meadows

***2.*** Create market gardens on the sunny meadow

***3.*** Build ponds, roads and houses on hillside

***4.2.*** Forest gardens between ponds
***4.2.*** Private gardens alongside housing

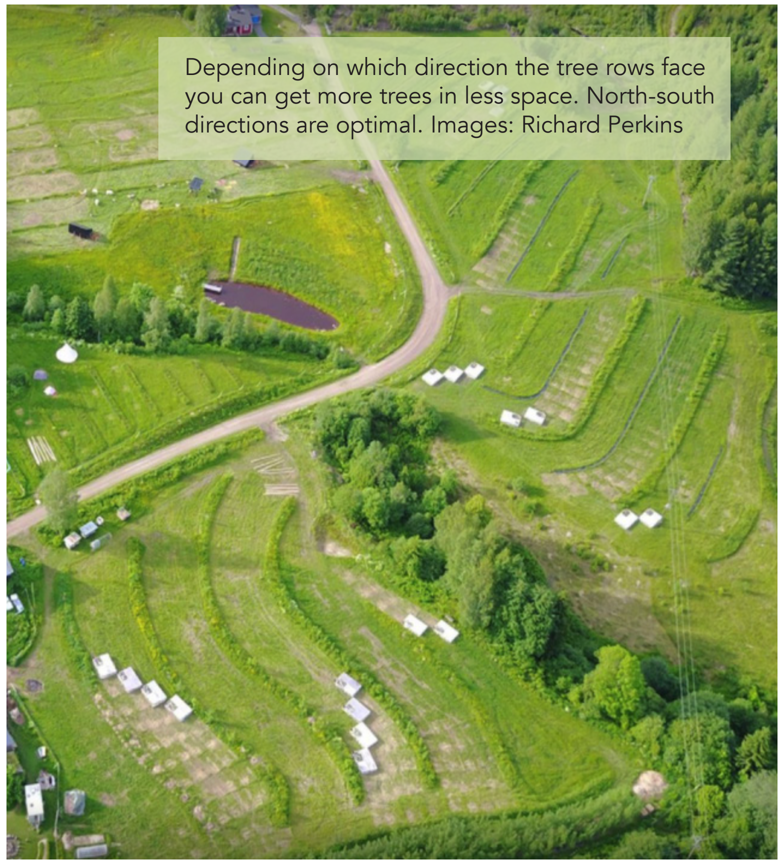
***5.*** Integrate pigs/goats/sheep to graze the hillsides






# 3.2.4. Bjällansås - Key interventions

## 1. *Integrate tree lanes and birds on meadows*



Depending on which direction the tree rows face you can get more trees in less space. North-south directions are optimal. Images: Richard Perkins

### Silvopasture lanes:

We can integrate 800 meters of silvopasture lanes just in the meadow shown in the design exploration on the previous page and thus provide additional income and food without affecting the quality of the grass production feeding the animals. By adding a total of 1200 meters of such tree lanes we can produce up to 300 fruit trees and 4300-8600 berry bushes depending on sun and the direction of the tree lanes. This can also provide a full time job (with 560-790k SEK in net profit) as the trees start bearing fruits and nuts. (Perkins, 2020: p. 245)

### Pastured poultry:

Between the rows of trees not on cattle can graze but we can also speed up regeneration of soil and ecosystem by integrating meat birds and laying hens. Pictures and numbers are from Ridgedale farm where Richard Perkins integrate poultry with grazing sheep and cows (smaller flocks). His numbers show that we can produce 7 tons of chicken meat or 5 tons of turkey on just 2,5 ha of grazing area. This meat could feed 424 people (with average consumption of 16,5 kg/pers per year). When it comes to eggs slightly more land is needed but on 4,8 ha we can have 1200 grassfed laying hens, producing 300 000 (18 ton) eggs, enough to feed 450 people 2 eggs per day each year. Each of these enterprises could also provide income enough for another full time job (Perkins, 2020: p. 323+385).

## 2. *Market gardens on the sunny meadow*

### Market Gardens

Establish vegetable gardens on the sunny meadow (can fit up to 1500-2100 sqm of bed space including existing garden). The space is more than enough for 1-1,5 full time jobs as a market gardener with a net of 490 000 -680 000 sek (Perkins, 2020: p. 505). With a harvest of 6,4-9,6 ton vegetables/year (feeding 32-48 people) [Hansson, 2021].

Even if 8000-10 000 sqm of the 3,8 ha meadow becomes vegetable garden beds, paths and functions around these 2,8-3 ha still remains for grazing. This only affects the access to grazing for cows minimally while providing many new jobs, more food and more carbon sequestration.

*Images: Richard Perkins*

# 3.2.5. Bjällansås - Key interventions

## 3. *Build ponds and roads on the north hill and build tiny houses here with a view*

### Keyline ponds and roads

Building dams in the keypoints we are able to capture water as high in the landscape as possible and store it for use in vegetable gardens, for animals etc. By placing roads on the dam walls they can also catch water runoff and lead it into the dams.

### New tiny houses

The best location for housing is also at the slope switch (close to these keyline ponds) - ideally the south facing slopes which can now be accessed via the new roads. If the houses have the long facade at 20° angle to the south they also let in maximum amount of sun in winter and shade in summer when sun stands higher (Millison, 2021).

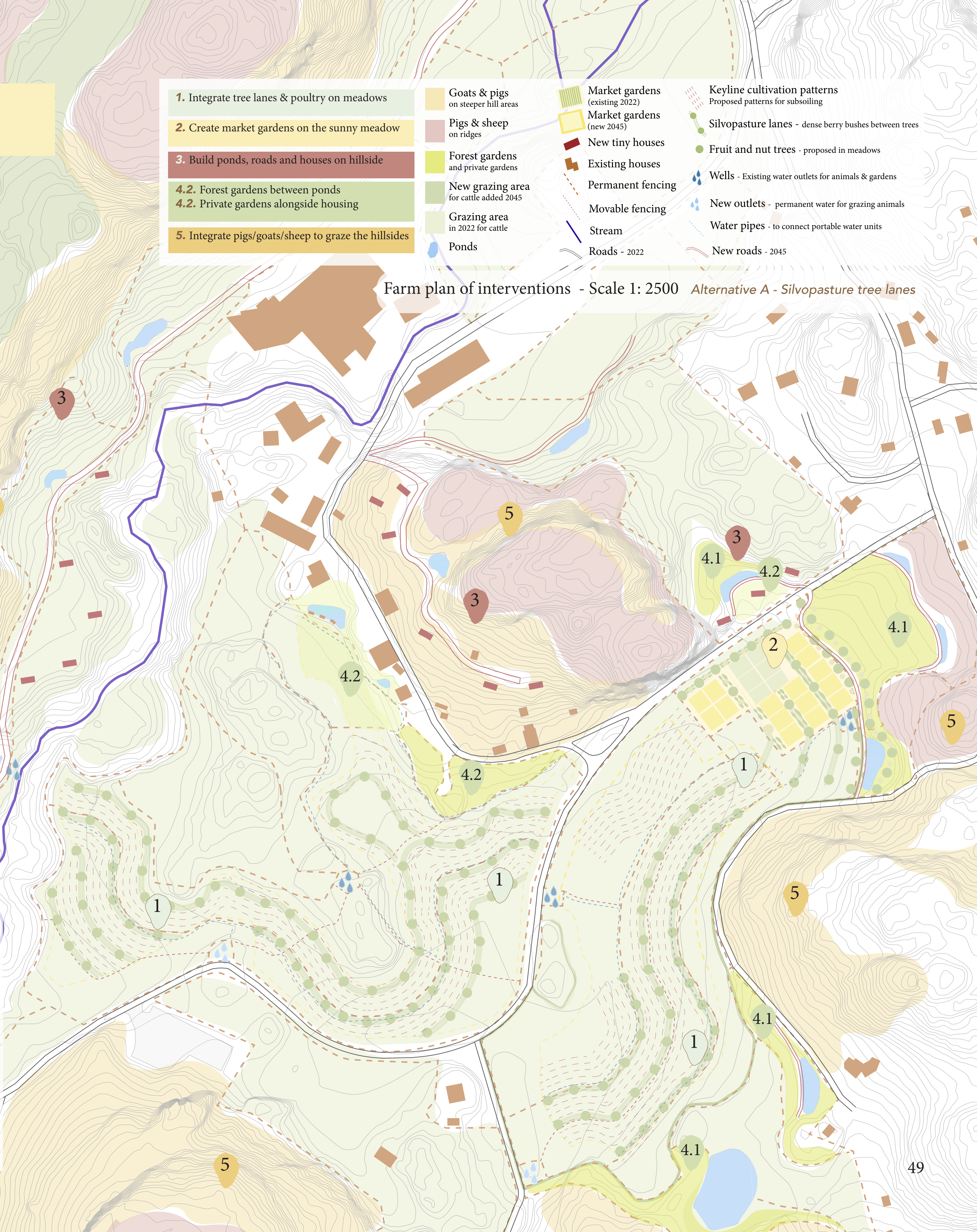
This green area on the hillside previously was an open field with grains grown in the past however it was planted as a spruce forest (monoculture) that could be opened up into a using pigs initially, then cattle - similar to methods by Perkins (2020) and Vattholma Agroforestry (2022). Eventually even housing ponds and gardens or crop fields (when there is more sun again as the forest is more open).

## 4. *Forest gardens along housing and ponds*

Some areas were not suitable for silvopasture tree lanes as they are to steep for both machines and animals. These areas could instead be transformed into edible forest gardens mimicking an ecosystem of a forest but providing edible crops, fiber/energy and medicine. Other areas close to the housing could be used for private gardens as they have plenty of sun for annual crops but are too small for larger market gardens.

## 5. *Integrate pigs/goats to revitalise forest on the hills*

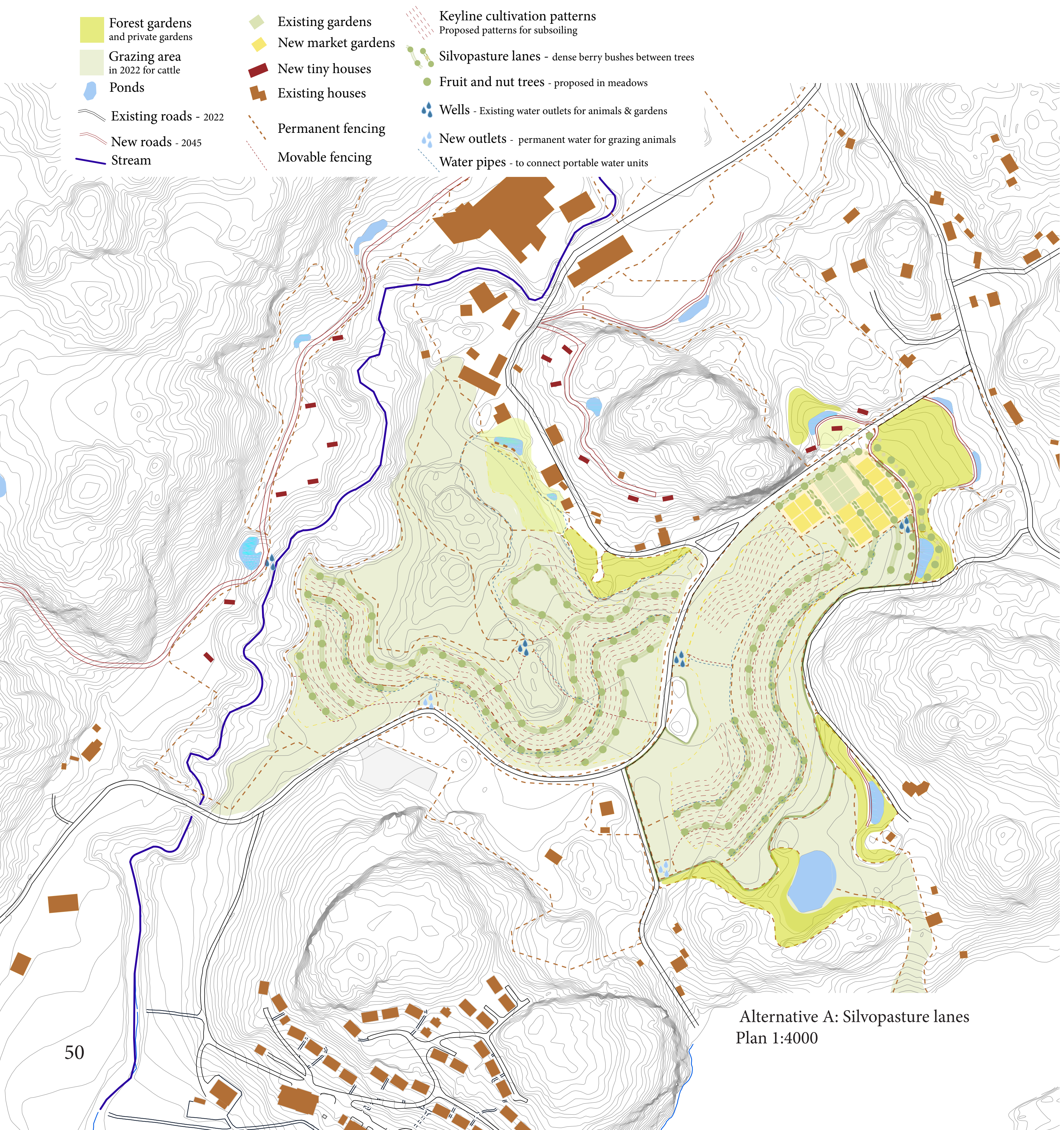
More food can be grown on on the same land  by integrating animals that can feed of what nature has to give in landscapes like steep stony hillsides or dense forests. This is what I propose for the hillsides that are not to steep or wet at Bjällansås farm. The pigs have special abilities to revitalise old pastures and transform conventional spruce monoculture to more diverse and open mosiak agroforestry and grassland ecosystems. Also goats can remove dense bushes and weeds and help renew ecosystems. After pigs have been "disturbing" the land shall be left to rest for some years but within a year it can they be grazed by cattle or sheep to reintroduce and wake up dormant grassland species, or maybe even crop fields once more.



# 3.2.5. Bjällansås - Design explorations

## *Iterated version of the design*

After a few iterations of design explorations the market garden was reduced in size and the silvopasture lanes placement were evaluated in relation to fencing and moving of animals. After feedback from the farm owner and managers I ended up creating 3 alternative design proposals and *Alternative B* is the version I feel combines the best of all three.



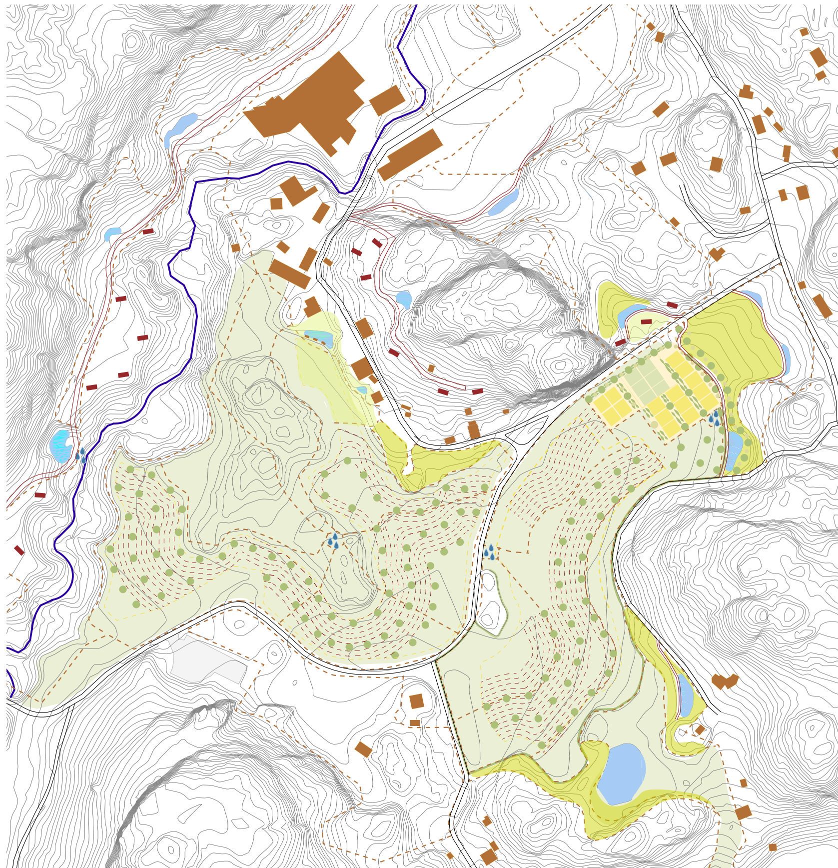

Alternative A: Silvopasture lanes
Plan 1:4000

## *Alternative layouts for trees and fencing*

As trees are usually more permanent in a landscape than fencing, at least according to the Keyline Scale of Permanence® (Yeomans, 1977), the placement of existing permanent fencing within each of the meadows on the farm was not considered when placing trees. Instead trees followed the keyline cultivation patterns in order to facilitate aeration of the subsoil, so subsoil could become topsoil, using the keyline plough. The result is that the tree patterning are somewhat in conflict with the current fencing and pose some critical problems to be solved, namely the practically of moving cows daily in big herds when placing trees along the keyline cultivation patterns:

1. *The existing internal fences are ideal to the current size of cows herds and each have access to water. If replaced new water infrastructure need to be considered.*
2. *Moveable fencing are not currently working in the context of the farm and large cow herds means smaller paddocks might be unrealistic.*

*Thus I created the following three alternative layouts for more or less ideal placement of trees vs. permanent fencing:*



Alternative B: Savannah tree patterns
Plan 1: 6 000

### A. Silvopasture lanes

*(to the left)*

Row spacings 18 m apart with trees 3-4 m apart within rows and berry bushes in between. Big risk of cows grazing on young trees/bushes and lanes need to be fenced out. Optimal alternative for maximum fruit and berry harvest and keyline subsoiling.

### B. Savannah style tree patterning

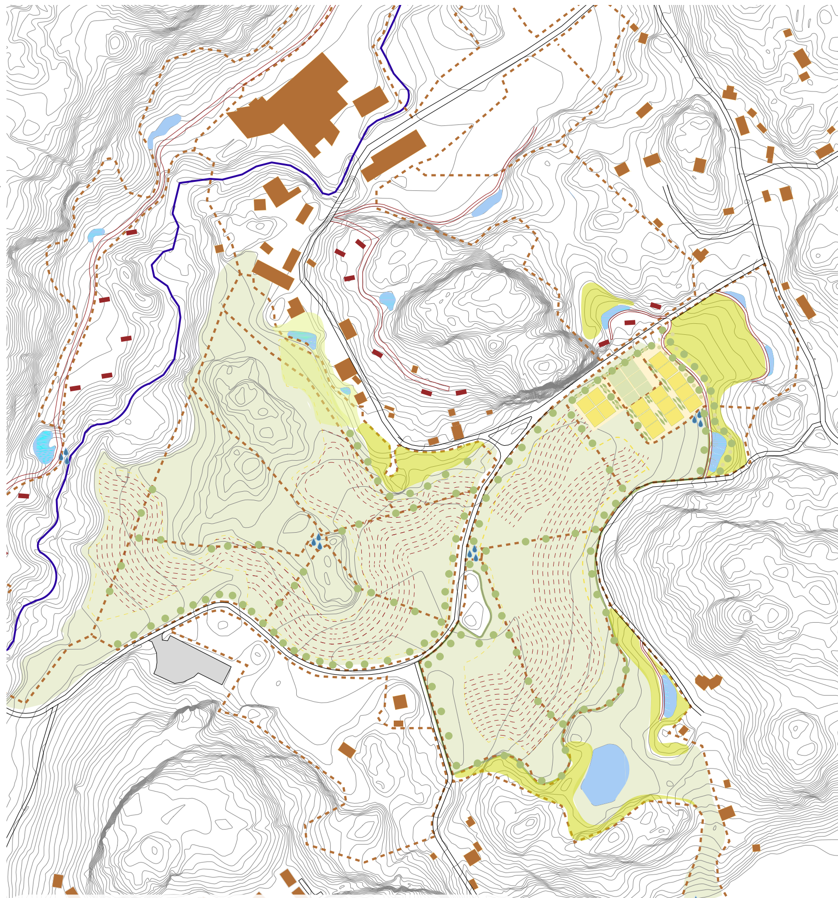
*(top right)*

With trees spaced out 18 m aparts even within rows following more of a grid pattern - allowing for moving of animals in both directions. Trees not sensitive to grazing might not need to be fenced to protect from grazing. A little less fruit/berry harvest but aligned with keyline subsoiling patterns.

### C. Trees along existing fence

*(bottom right)*

Trees placed out where they follow both existing fencing and new Keyline cultivation patterns, and roads (which provides good access to harvest). This compromise means we can keep existing fencing and still cultivate the subsoil to speed up the topsoil formation. Additional double rows of fencing or thorne bushes can protect young trees. The cons? Trees & fencing slightly interrupt keyline patterns.



Alternative C: Trees planted along existing fence
Plan 1: 6 000

# 3.2.5. Bjällansås - Key project


*Left:* Focus area for first key project
Scale 1:2500

## *What is the first step to get here?*

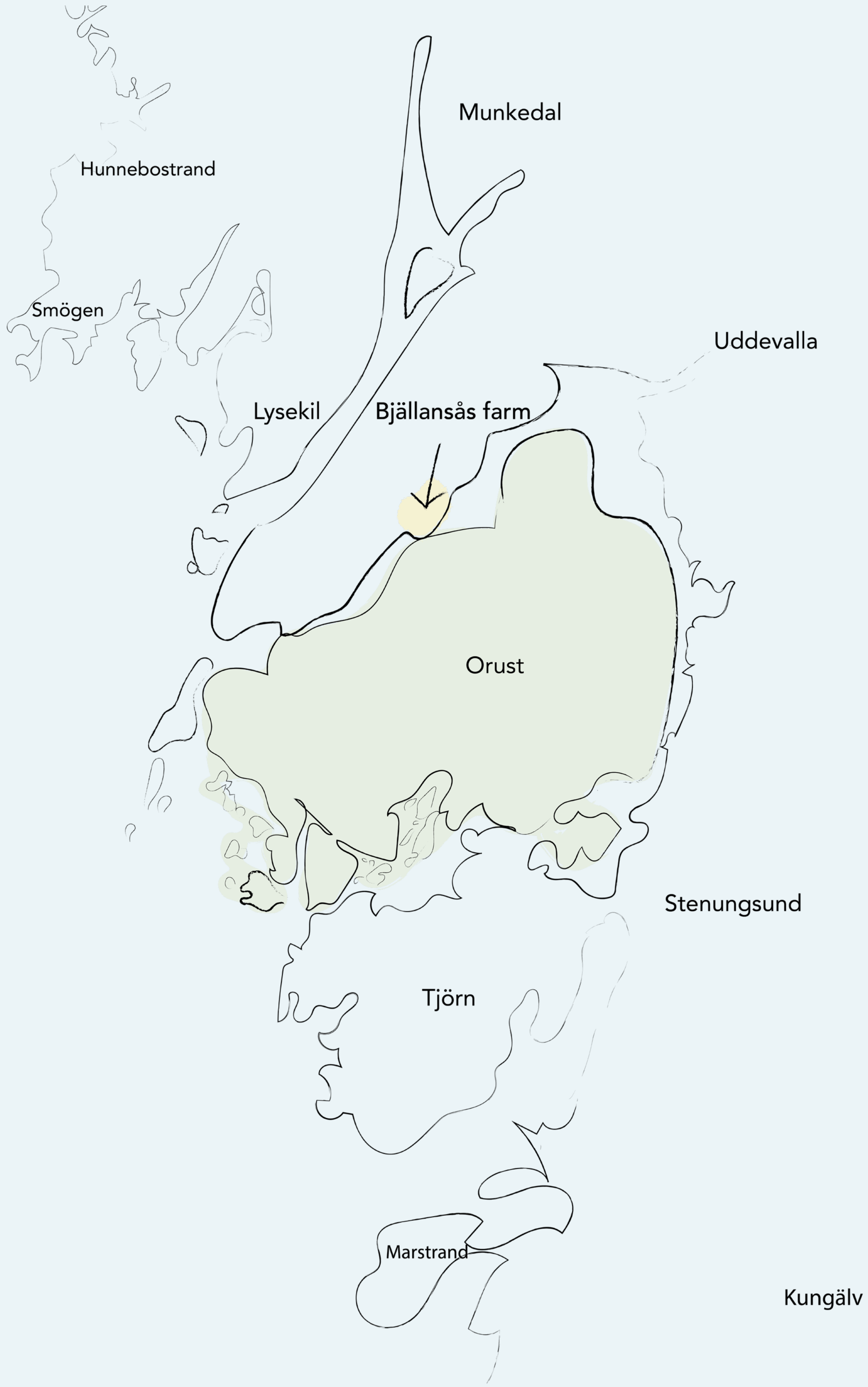
### Building trust through a collaborative market & forest garden

The most critical first step to realizing all these key strategies and regenerative agriculture enterprises is building relationships with people who can start them and manage them. Building relationships with neighbors and potential entrepreneurs moving in here is one of the main first goals of Bjällansås farm and this is done by inviting new people in and building trust by letting these people co-create their own holistic context as a group of what they envision on this place. This might look like the visions proposed here or it might not, the people of Bjällansås (current and future) need to determine this themselves. The focus area in which to start inviting the first group of people and build a pilot version of the farm enterprises, even in a very small scale, was identified together with the farm owners and manager; namely the area around the existing community garden as seen to the left.

Perspective of future scenario (Silvopasture lanes - *Alternative A*).




# 3.3. Orust municipality



# 3.3.1. Welcome to ORUST in 2045

Hi,
Welcome to the future of Orust, Swedens fourth biggest island! My name is Elin and I'm an Orust resident. I run a local food store on the island.

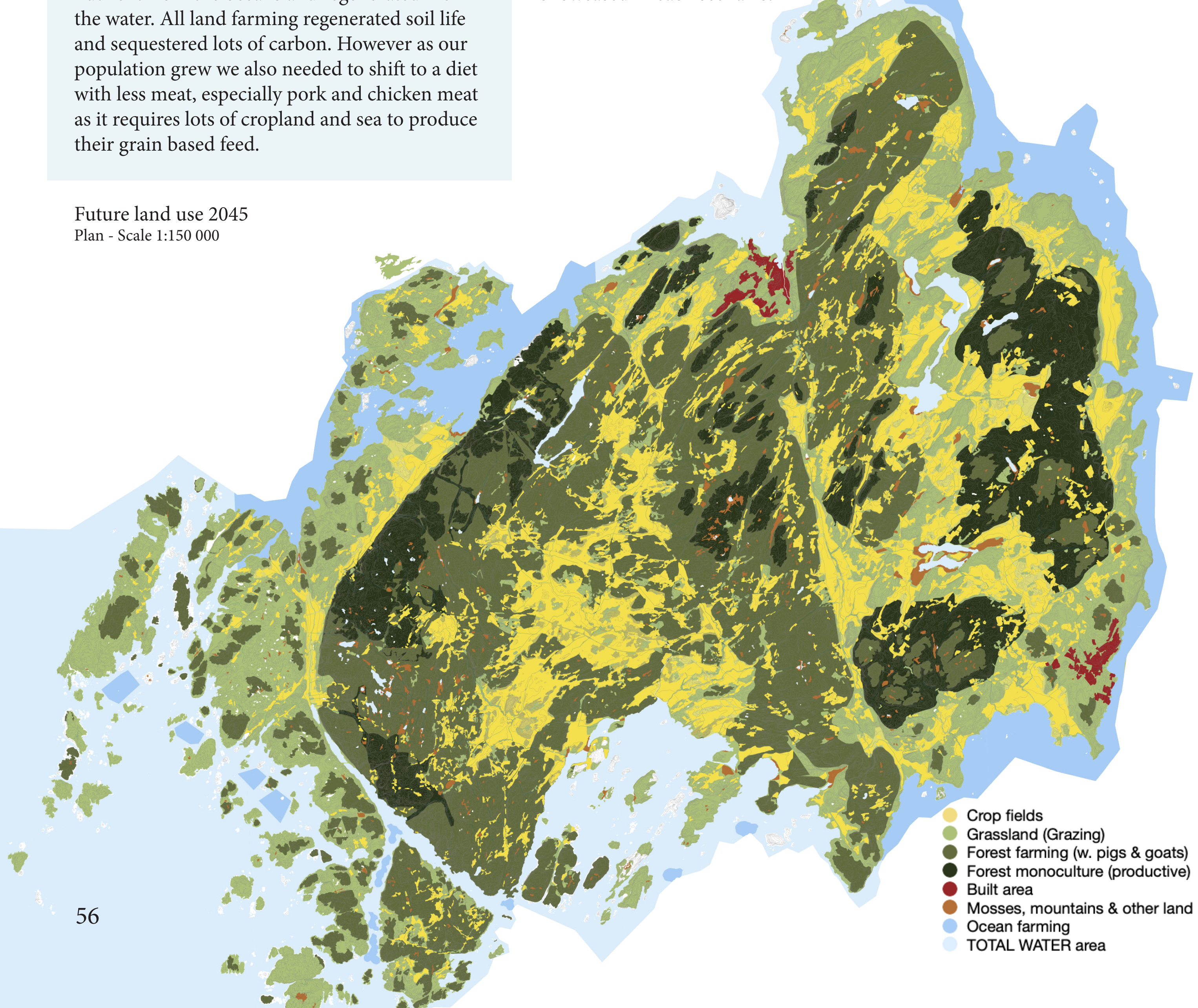
Today in 2045 we are more or less self reliant on food, even with a higher population and only import a few things from within the region. We also produced all this food while regenerating our ocean and land ecosystems through regenerative agriculture.

The land we have on Orust was just enough to feed the increased population and we had to be creative and open up our forests to grazing by sheep and goats as well as using pigs in regenerating our forests. We produced mussels and algea in the ocean to feed our birds and pigs which also filtered nutrient from the oceans and regenerated life in the water. All land farming regenerated soil life and sequestered lots of carbon. However as our population grew we also needed to shift to a diet with less meat, especially pork and chicken meat as it requires lots of cropland and sea to produce their grain based feed.

In this chapter you can read about the two scenarios (presented in chapter 3.1) of rurbanization and urbanisation and how it affected the municipality of Orust. You will be guided through this chapter by Elin, a future resident. But I will also explain my SWOT analysis and design exploration.

To sum up the work with scenario planning in Orust I have explored the two scenarios explained on the next page but will the land use map focuses on *Scenario A* (rurbanisation) and so does most of my design work. However I also based much of my work to be prepared for *Scenario B* (urbanisation and more extreme climate change) with a doubled population. In both scenarios the available land limited the population. Thus, in order to survive in scenario B they had to eat less meat and only about 40-52% of the diet (in grams) is animal products. I also included calculations of how Orust could be self reliant with the current population in 2025 (lets call it *Scenario C*) based on eating similarly to what they eat today. The three diets are represented in the plate models showcased in each scenario.

Future land use 2045
Plan - Scale 1:150 000





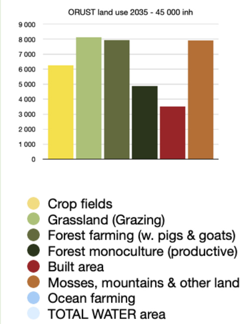

## *Two scenarios of population growth*

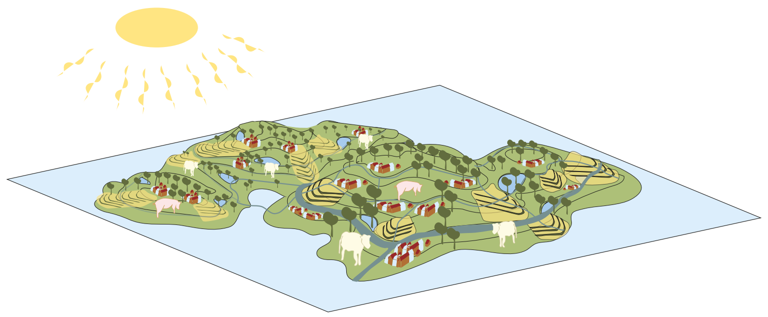
### Scenario A - Population increases with 50%

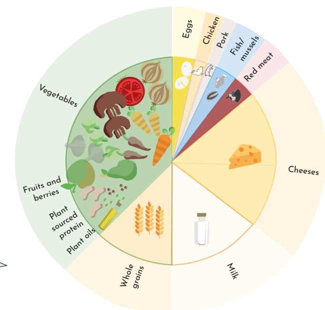
Total land use needs for 22 500 inh + 45 000 summer inh. 6 months (≈45 000 inh)

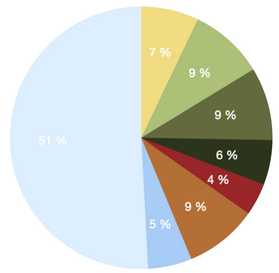
Total farmland (grazing+fields+forest farming) = **22 335 ha**
- Open fields (cropland + vegetables) = *6 264 ha* (of which *700 ha* is vegetables)
Forest grazing & grassland (silvopasture + forest animals)= ***8 116 + 7 955 ha***
- Grassland with trees (sheep/cow/hens) = *8 116 ha* (20 kg meat + 13kg cheese + 125 l milk)
- Dense forests (pigs+goats) = *7 714 + 241 ha* (16 kg pork /person + 6kg goat cheese)

Ocean farming (mussels/algea) = ***4 769 ha*** (mainly for animal feed)





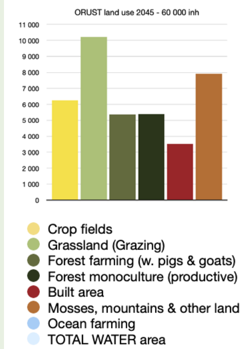

*52% of food is animal products*
Scenario A

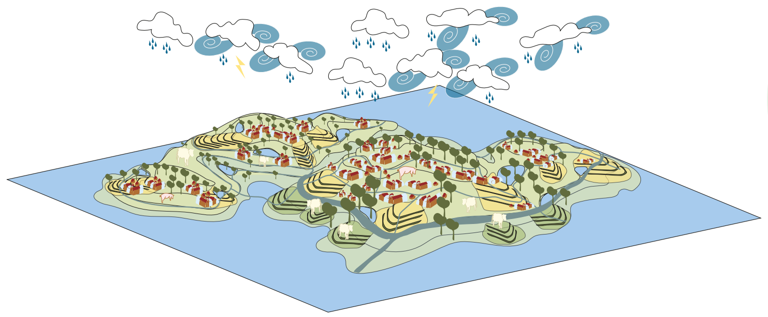
### Scenario B - Population doubles

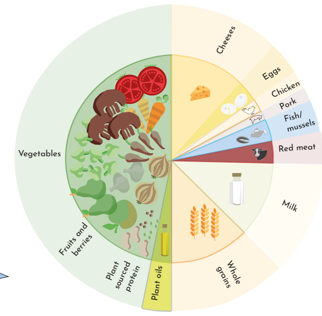
Total land use needs for 30 000 inh. + 45 000 summer inh. 8 months (≈60 000 inh):

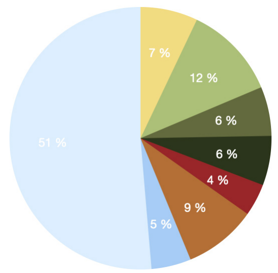
Total farmland (grazing+fields) = **21 830 ha**
- Open fields (cropland) = *6 254 ha* (of which *840 ha* is vegetables)
Forest grazing & grassland (silvopasture + forest animals)= ***10 219 + 5 357 ha***
- Grazing land (sheep/goat) = *10 219 ha* (8-16kg lamb + 6kg cheese+ 90 l milk /person)
- Dense forests (pigs+goats) = *5 357 ha* (8 kg pork /person + 4kg goat cheese)

Ocean farming (mussels/algea) = ***4 325 ha*** (mainly for animal feed)






*40% of food is animal products*
Scenario B

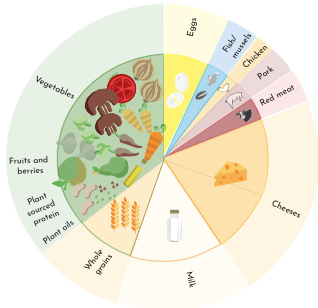
# 3.3.2. Orust today, 2022

Back in 2022 we had about 15 000 inhabitants and an additional 45 000 people staying here during 4 summer months. The farmland we had available was more or less just enough to produce what we needed. But we did not farm as much then, not nearly enough to be self reliant.

Already in 2012, Orust was largely self-sufficient in beef and lamb as well as milk. There was enough for some cheese too. Some apple orchards had been created and potatoe production existed but only covered under 10% of our needs. In terms of pork, there were a few but far from enough to cover our consumption. The eggs produced covered about 10% of the needs. All these numbers were calculated by Orust Mat (Ivarsson, 2021).

If Orust is to be self reliant in 2025 on food using only the land available on the island (what I call *Scenario C*) it would barely be enough to cover for the dietary needs of the current inhabitants including the summer residents (which equals about 30 000 full time residents). The estimation on the bottom of the next page shows the land use needs and needs for ocean farming to produce enough animal feed for pigs & hens etc in a regenerative manner.

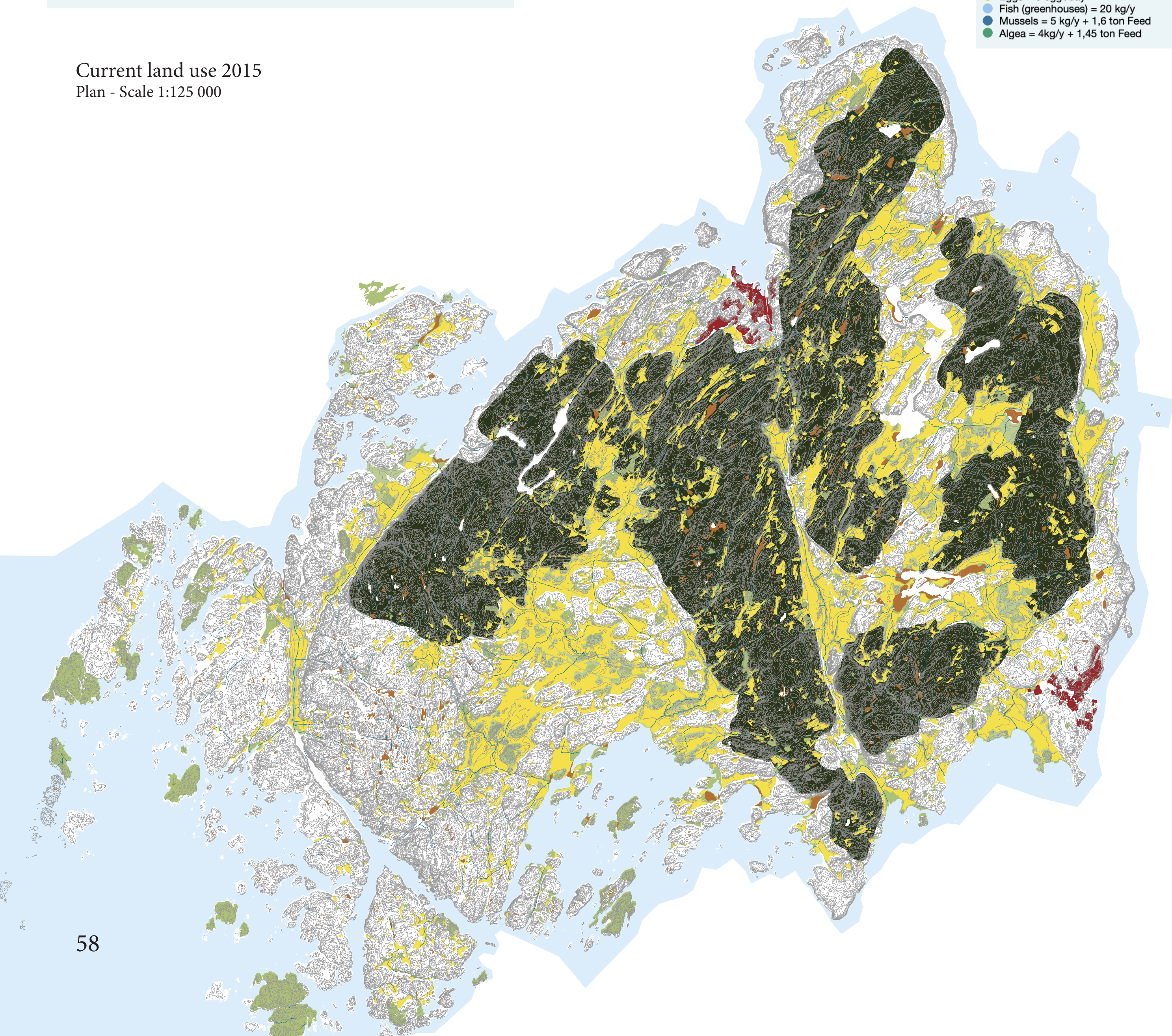
The illustration to the right shows the current diet I based the calculations on, with slightly less pork compared to we ate in 2022.




54% of food animal products.
People consume the following:

- Vegetables = (183kg/y)
- Fruits = (73kg/y)
- Nuts = (18kg/y)
- Potatoes = (45kg/y)
- Grains = (85kg/y)
- Milk = 3,5 dl/ day (125 l/y)
- Cheese (cow = 13kg/y)
- Cheese (goats) = 6kg/y
- Beef & lamb - 85 g/day (22+8 kg /y)
- Pork (55 g/d, 20 kg/y)
- Chicken/poultry = 55g/day (20kg/y)
- Eggs = 3 egg /day
- Fish (greenhouses) = 20 kg/y
- Mussels = 5 kg/y + 1,6 ton Feed
- Algea = 4kg/y + 1,45 ton Feed

Current land use 2015
Plan - Scale 1:125 000





## *How much land is needed to feed 15 000 inhabitants?*

Who would have thought we needed to become self reliant on food and how much land us acutally needed. Facing the war in Ukraine in 2022 we started making a strategy and setting goals for becoming 100% self reliant on all the food we needed. To feed the current inhabitants we soon realized we needed to expand our grazing land into both fields and forests. We both opened up dense forests using pigs and goats and also planted tree rows on our fields, meaning most of our landscape became what is called agroforestry - integrating agriculture with forestry. Integrating trees with both animals and crops has a potential to capture more carbon and more food, regenerating our soils.

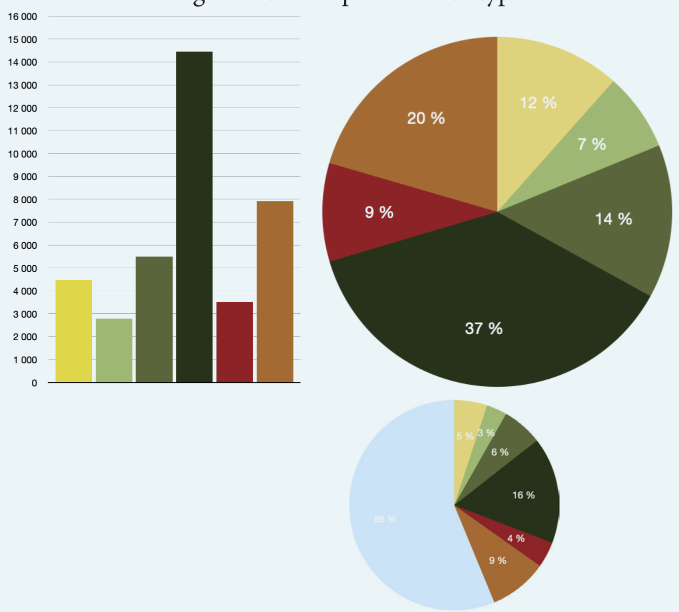
### LAND USE TODAY:

Productive forest = ca. **14 451 ha** [JBV, 1977]
Grazing (grassland) = *2310 ha*
Fields with permanent grass/crop = *483 ha*
Total grazing = *2793 ha*
Fields (cropland) = *5419 ha*

**Total farmland = 8 212 ha** (Åker & Bete) [JBV, 1999]

**9 ton** emissions
**-0,5 ton** net land use sequestration (NVV, 2021)
**+8,5 ton** net emission / capita

***Orust land use 2015***
Diagrams of area per land use type




## *What is the potential to feed the current population?*

### Land needs current inhabitants:

15 000 inh + 45 000 summer guest 4 months
(≈ 30 000 inh.)

Dense forest grazing = *9 225 ha* (Pigs & goats)
Commercial forest = 2 223 ha

**Total forest area = 11 448 ha**

Grazing w. trees = *11 280 ha*
(Silvopasture, cows, birds, sheep)

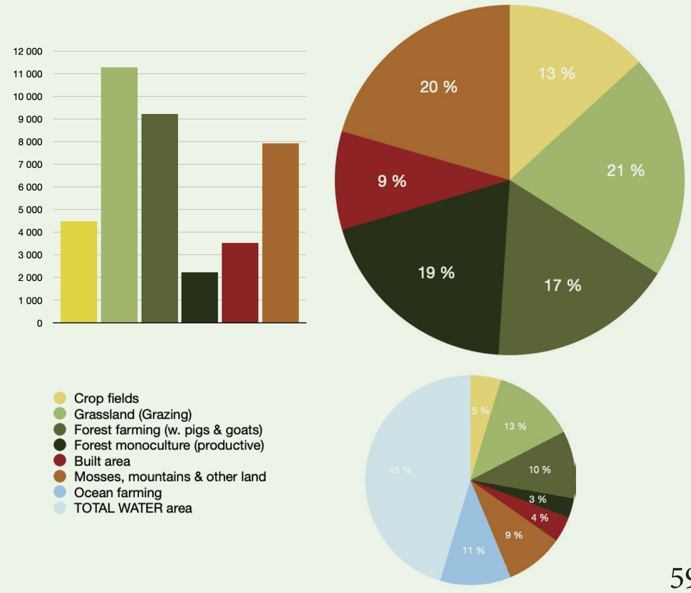
Fields (Åker) w. trees = *3 912 ha*
(Alleycropping, grains, potatoes, nuts, fruit)
Market gardens (finer fields) = *570 ha*
(vegetables)

Total field area = ***4 482 ha***

**Total farmland = 24 987 ha**

**Ocean farming=** *+7 131 ha*
(Mussels + Algea)

***Self reliance on Orust 2025?***
Diagrams of land and water needed to feed all inhabitants



# 3.3.3. Orust - SWOT

## *Site observation and SWOT-diagnosis*

As a summary of my site observations and geographical analysis using the Keyline scale of permanence and my *holistic planning framework* I did a SWOT analysis of Orust and the islands current strenghts, opportunities, weaknesses and threaths.

### S

*Varied landscape with good access to arable land.*
- Valuable farmland in flat open fields.
- Forested hills protect from erosion.
- Near ocean, still protected from wind

*Strong social capital and a culture of cooperation and self reliance*

*Decentralized population*
Inabitants not concentrated in one urban center, making services more equally distributed.

### W

*Topography and placement of roads brings risk of erosion:*
- Some farmland and roads in valleys has high erosion risks.

*Some water bodies has lots of eutrification*

*Only a few main connections to mainland*

### O

*Potential of self reliance on food*
- Open farmland can feed 15 000 ppl
- With bigger population more land could be opened up for grazing / agroforestry.

*Potential for urban growth*
- Many people want to move to Orust
- Potential to spread out population with good access to farms/farmland

*Potential to regenerate land/oceans:*
Increase soil carbon to increase water and nutrient holding capacity, capture $CO_2$ & reverse eutrification through ocean farming.

### T

*Climate change & extreme weather -*
Sensitive to heavy storms and rainfalls & droughts - both farmland, roads & risk of flooding coastal areas.

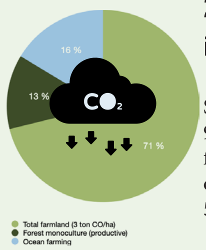
*Imports could stop if bridges are cut off (due to war or weather).*

*Refugee crisis could make population change to fast:*
- Tourism & population rising higher than ability to feed the island due to war and climate refugees coming to Sweden.

## Opportunity = Potential for sequestration for 30 000 inh

**2,63-7,63 ton $CO_2$ / capita***
= 30-85% of current consumption emissions of 9 tons.

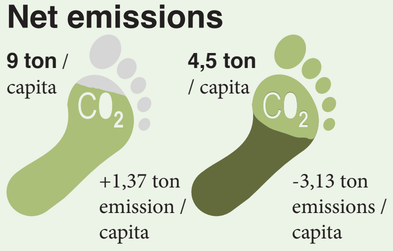
*If we emisions are halved to 2030 like regional goals (VGR, 2022) we can sequester 60-170% of our emissions.*




**228 759 ton $CO_2$**
in total**

Sequestered in total ≈ 71-90% on 21 800 ha of total farmland, 13% on 4300 ha ocean farming and 3-9% on 5400 ha productive forest.

**Net emissions**




*The numbers are based on research explained on page 67, based on a current population and 100 % self reliance (Scenario C).
**Based on research estimates of agroforestry methods, explained on page 67.



# 3.3.4. Orust - Infrastructure

## *Feeding the people through local food distribution*

### Food nodes and rural hubs

In order to distribute food and have basic services available over the whole municipality I propose food nodes spread out evenly across the island. The 15 food nodes each represent approx. 1500 ha oof food production and thus 5-10% of Orust food. The food from here can be distributed to the village nodes and its grocery stores via a fine-mesh network and the distribution here can replace the REKO-rings' sometimes problematic transport challenges witheach consumer going to the market in their own passenger cars. Instead we can coordinate a distribution in collaboration with the post or similar actors.

### Distributing food to all islanders

The food nodes also become distribution nodes for animal feed. Waste from milk, eggs, fruit and vegetables, nuts, cereals, etc. is transported to one or more rural nodes where it, together with mussels and algae from a dozen aquaculture nodes (via its nearby food nodes), can become animal feed.

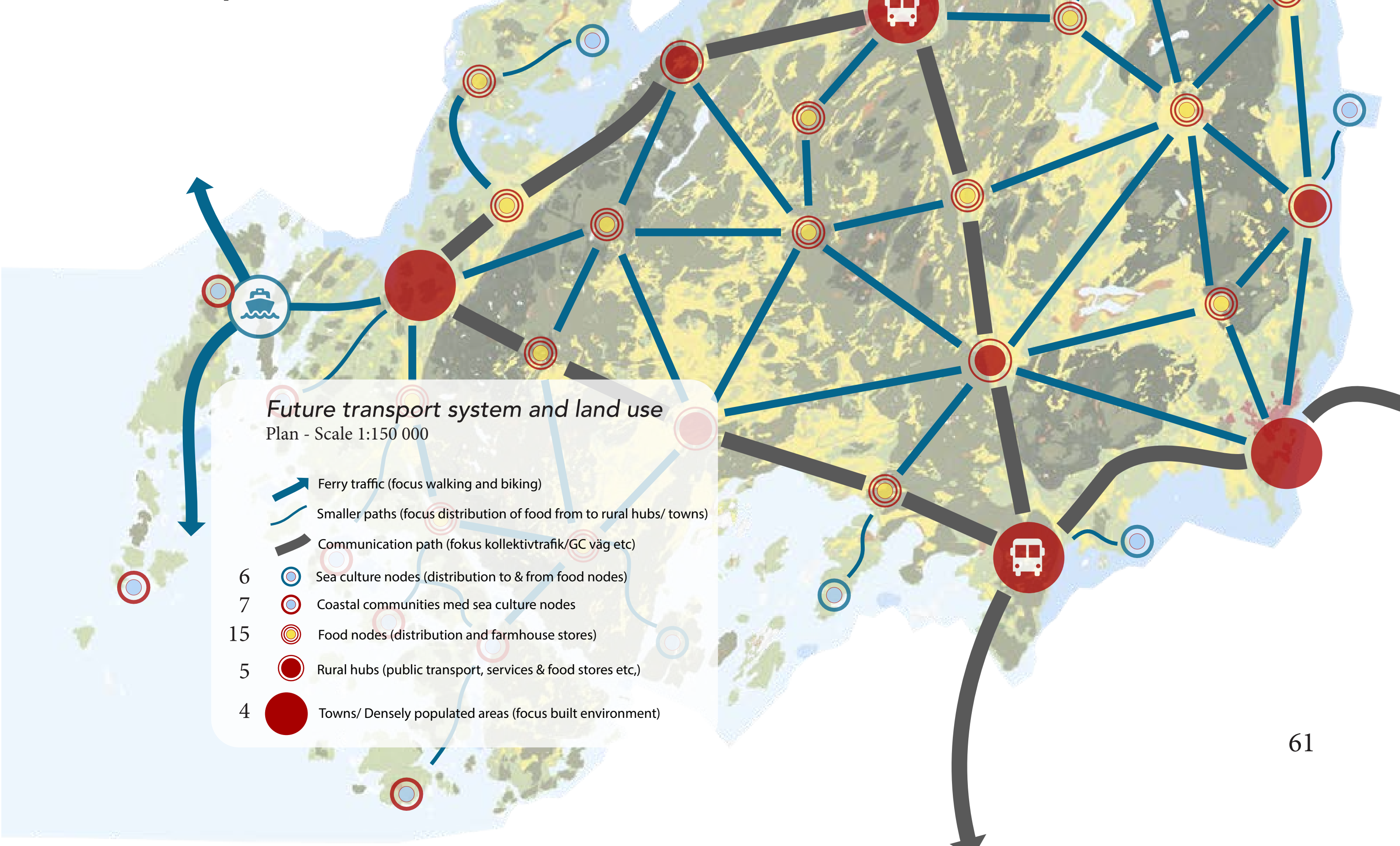
The transformation takes place in small-scale feed industries that in the long run replace the production of laying feed, pig feed and fish feed. Cereal feed (which is to be used very sparingly) for animals can also be produced and distributed here.

### Decentralized system distrubution

Seen in the diagram below shows 5 rural hubs, and 15 smaller food nodes to act as food distribution hubs and market places with meeting places around food. Here self run food stores could eventually be opened where local farmers can sell their produce. These nodes can also house community and educational farms.

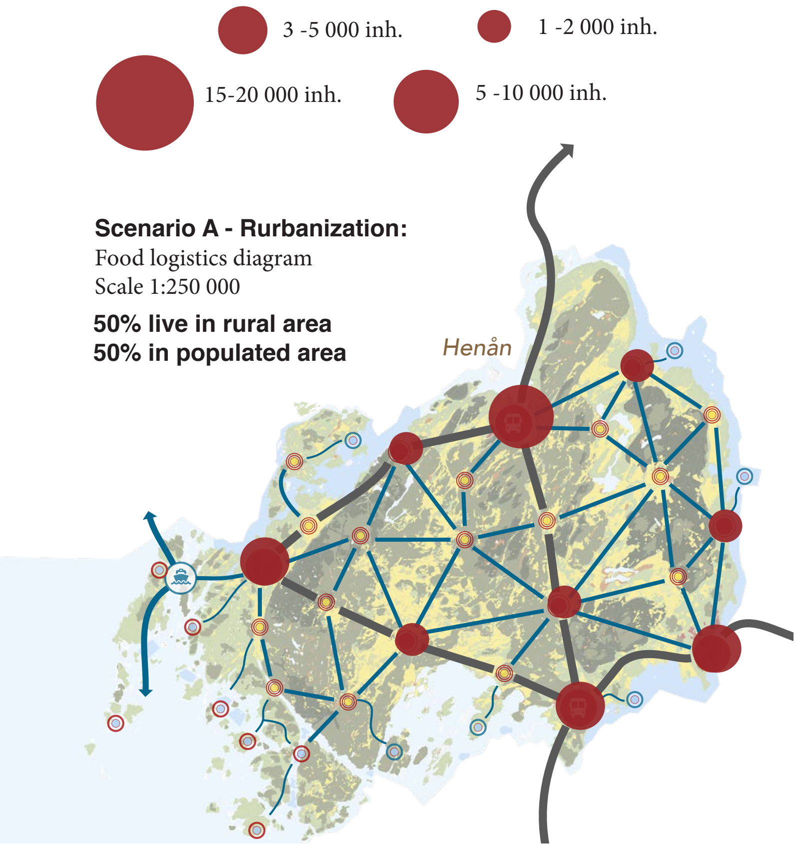
*Why so dense between the food nodes?*

***Well there are many reasons:***
1. *In a future with little transport by car most of the transports of food will be via bike/foot*
2. *To ensure everyone has a food store in walking distance including farm deliveries.*
3. *The hubs also collect food waste and sea farming products for animal feed - the nodes supplying bigger rural hubs need to be close to both sea culture and food nodes.*
4. *To provide a complete network of bike and walking roads connecting urban areas.*



# 3.3.4. **Orust** - Scenarios of growth

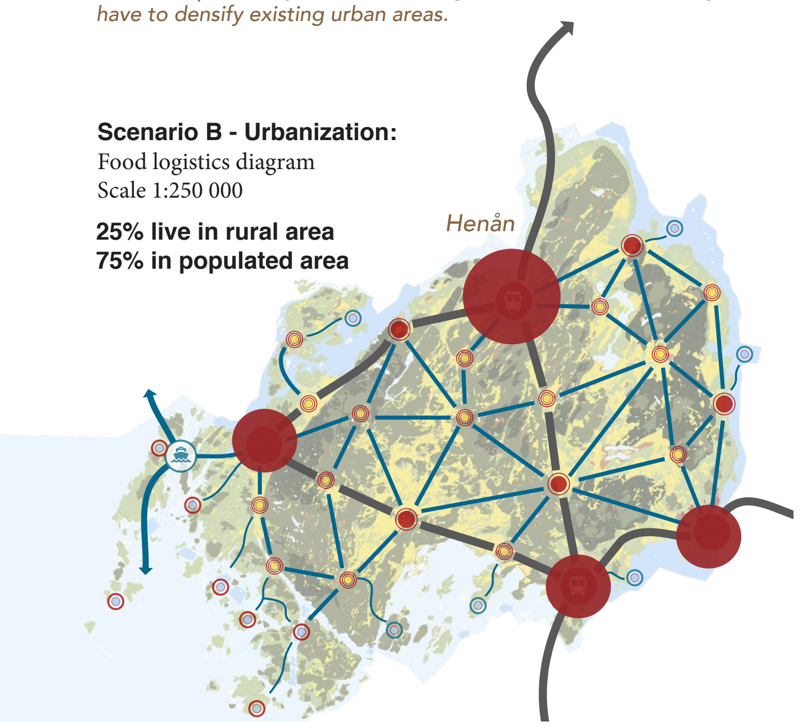
## *Two Scenarios - Rurbanized or urbanized populations*




**Scenario A - Rurbanization:**
Food logistics diagram
Scale 1:250 000

**50% live in rural area**
**50% in populated area**

*There is a risk of bigger land use footprint from the built area. However, total built-up area must not increase by more than 12-15% in both scenarios, preferably not over existing ones. Which means that you have to densify existing urban areas.*




**Scenario B - Urbanization:**
Food logistics diagram
Scale 1:250 000

**25% live in rural area**
**75% in populated area**

*How is food distributed to 45 000 inh. living in urban areas?*

### Scenario A

This is the best case scenario where we have reached carbon neutrality in Sweden already in 2030 - without major world wars and where pandemics have led to a regional society with self-sufficient regions and multi-core local structures.

### Rurbanized Orust

In this scenario Orust has 22 500 full time and 45 000 half time residents (meaning 67 500 people in total). 33 750 residents (50%) lives in urban and rural. If summer houses are well used in the winter time and houses can be shared it means housing equivalent to 22.5 thousand inhabitants (t. inh.) are needed in urban areas and rural areas respectively. There are 10-15 thousand full time employments in agriculture and / or the hospitality industry by people living in rural areas. 5 000 -10 000 farmers manages a total of 30,000 ha of land and aquaculture. 5-10t inh. live in the Henån urban area and 12.5-17.5 t. inh. live in other densely populated areas of between 2.5-5 t. inh. Instead of 2 urban areas, there are now 4-8 such areas, including Henån and new rural nodes.

### Scenario B

World wars and climate chaos mean that refugee flows from the EU and the world are doubling the population on Orust and VGR. We have to use less land per capita for both food, forestry and buildings - and more people live in cities and towns. But the countryside still lives and thrives as it supplies all towns and cities with food. Therefore, we must also start eating less meat and animal products in order to survive on the land within the municipality and region. Sweden became climate neutral in 2045, and included consumption emissions in the targets, but had to rely on higher measures of carbon sequestration with a doubled population. Globally, we are a little behind, but food and energy crises and food shortages due to depleted soils and drought are leading to a global shift to regenerative agriculture.

### Urbanized Orust

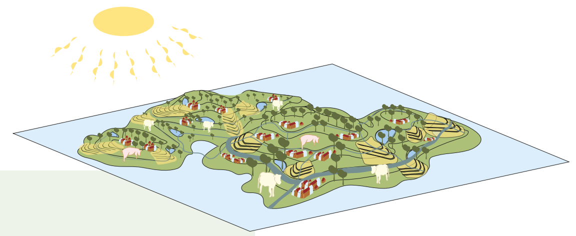
In this scenario Orust has 30 000 full time and 45 000 summer residents living here 8 out of 12 months (75 t inh. in total). This is equivalent to 60 t. inh. of which 45 t. inh. (75%) live in populated areas 15 t. inh. (15%) live in rural areas. The people who live in the countryside work in agriculture and / or the hospitality industry. The remaining live in Henån (15t) and the remaining (30t) are spread over other urban areas.



# 3.3.5. **Orust** - Carbon drawdown

## *How much $CO_2$ can we sequester in these two cases?*

### Scenario A:
Potential sequestration for 45 000 inh

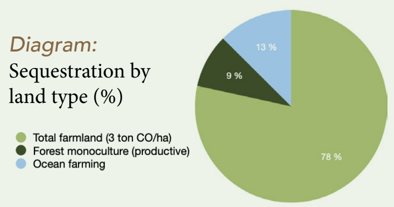


#### Net emissions

**4,5 ton** / capita
**118%** sequestered

-0,84 ton emissions / capita

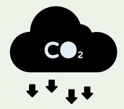

*Diagram:*
Sequestration by land type (%)



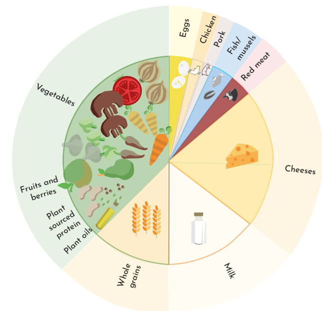

#### Sequestration

**1.6- 5,34 ton* / capita**

We reached our regional goals to half our consumption emissions to 4,5 tons (2030) and around 35-118%** of these emissions in Orust are negated through regenerative farming. We have now become "carbon positive" and sequester 18% more than we emit!

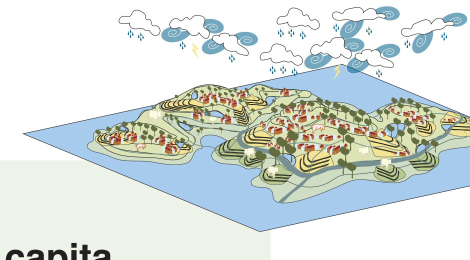


**251 045 ton*** in total
76-93% on 21 800 ha of total farmland,
13% on 4300 ha ocean farming and
3-11% on 5400 ha productive forest




Scenario A

### Scenario B:
Potential sequestration for 60 000 inh



#### Net emissions

**4,5 ton** emitted per capita
**90%** sequestered

+0,44 ton emissions / capita***

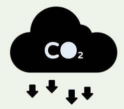

**3 ton** emitted per capita
**135%** sequestered

-1,06 ton emissions / capita

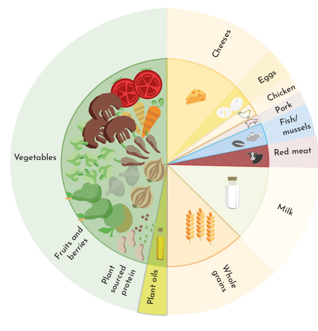

#### Sequestration

**1.31-4,06 ton* / capita**

We reached our regional goals to half our consumption emissions to 4,5 tons (2030) and around 30-90%** of these emissions in Orust are negated through regenerative farming. As emissions are lowered further, to 3 tons/capita, in 2045 we became 35% "carbon positive" and sequestered 1 ton more than we emitted!



**243 578 ton*** in total
78-93% on 21 800 ha of total farmland,
4-13% on 4300 ha ocean farming and
3-9% on 5400 ha productive forest




Scenario B

**$CO_2$ equivalents sequestered*
** Estimate of CO2 sequestered, lower number is based on swedish research at SLU of 3 ton/ha (Kätterer, 2022) and higher number on global research on agroforestry with 11 ton/ha, sometimes even higher (Toensmeier, 2017).
***Footprint diagrams are based on higher estimate.

# 3.3.6. Orust - Design exploration

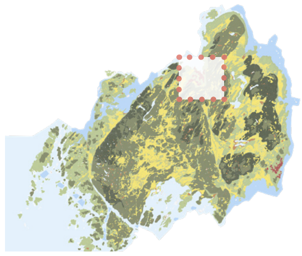
## *Zoom in Case 1 - Henån*

### Urban growth without removing farmland

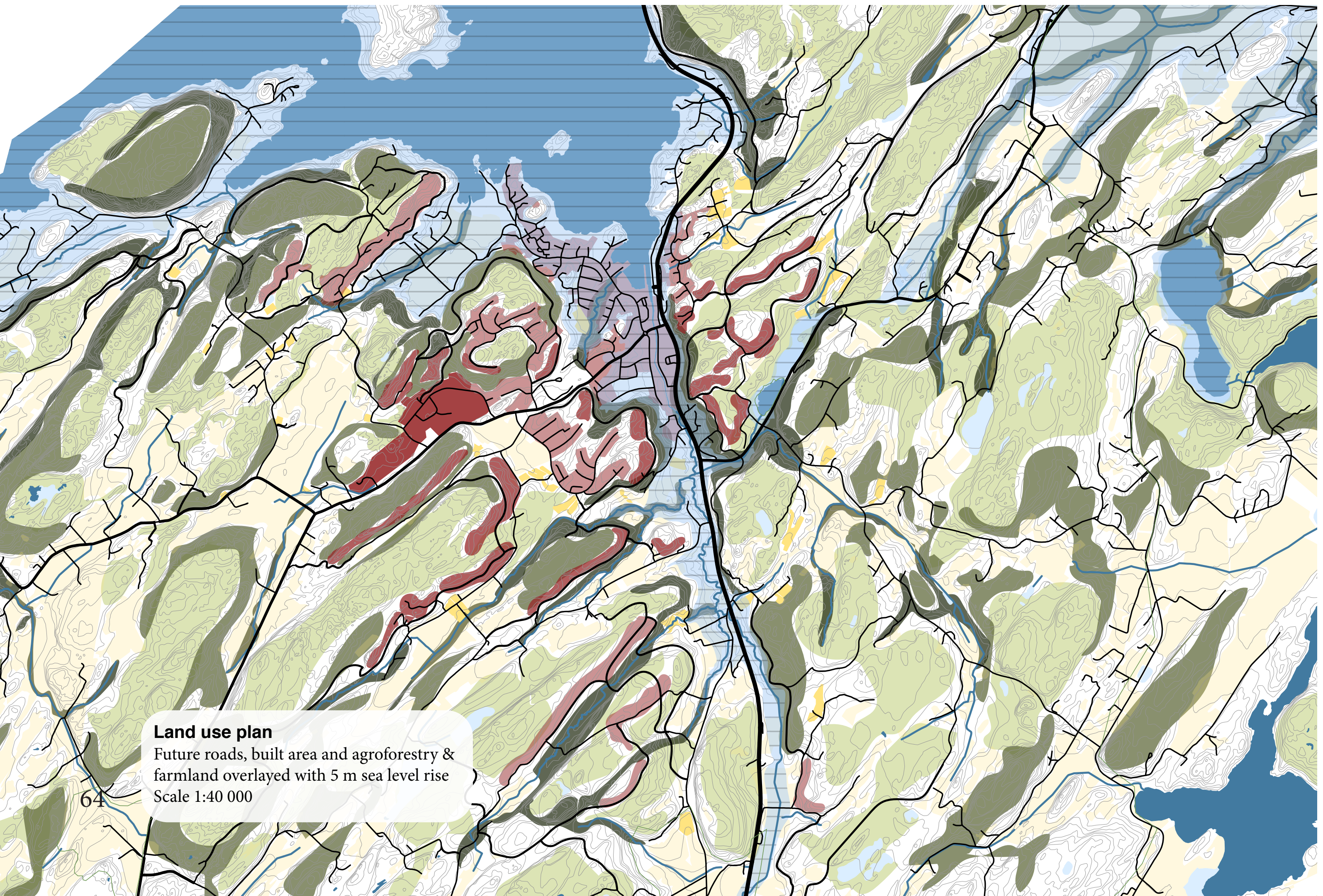
**A big potential conflict is between expanded built areas and existing farmland**
Henån (the main populated area on Orust) will likely experience a growth of population to between 5 000 -15 000 inhabitants from todays 2 500 as mentioned previously. What will this entail for Henån? How can we avoid valuable farmland being built upon and how do we ensure a resilient and regenerative future adapted to climate change where a growing population can be fed (meaning more and not less farmland)?

The design exploration is based on design goals with 3 criterias of regeneration (inspired by John Elkington's revision of the triple bottom line in the book "Green swans" (2020):

- Responsibility: *Can we meet the needs of both current and future generations in terms of protecting valuable farmland by building service and infrastructure /roads where potential built areas are more appropriate and thus avoiding urban sprawl in the midst of farmland around existing roads?*
- Resilience: *How well will roads and new buildings here cope with climate change and extreme weathers like 100 year rains or sea level rise leading to 5-6 m higher water tables?*
- Regeneration: *How well will this allow for regenerative agriculture and land use and the building of rich topsoil on as big of a surface as possible?*



*If Henån grows to 10-15 thousand inhabitants it will house 22-33% of the population meaning that about 7000 ha of land farming and 1500 ha of sea farming is needed to feed the inhabitants.*

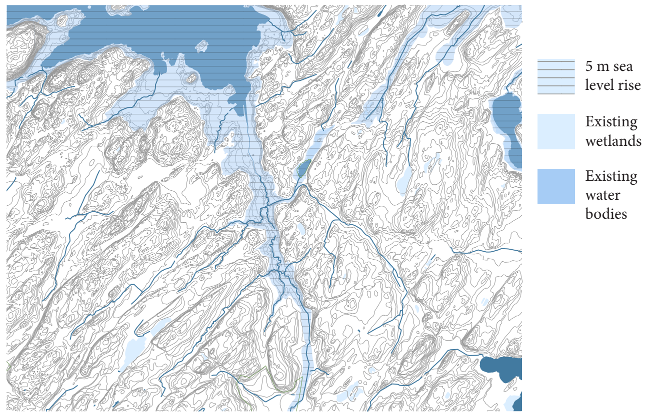


**Land use plan**
Future roads, built area and agroforestry & farmland overlayed with 5 m sea level rise
Scale 1:40 000

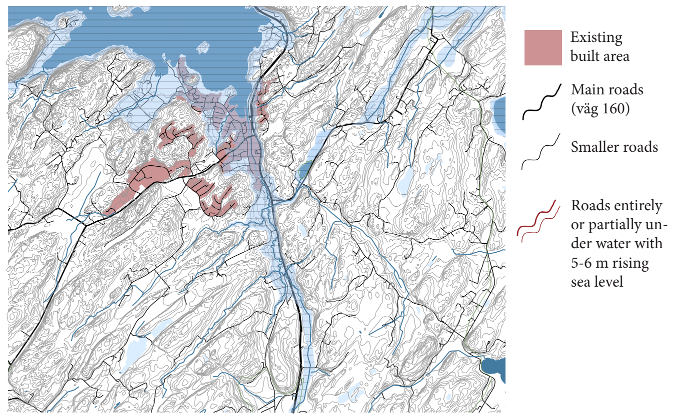


# 3.3.6. Henån - Keyline design process

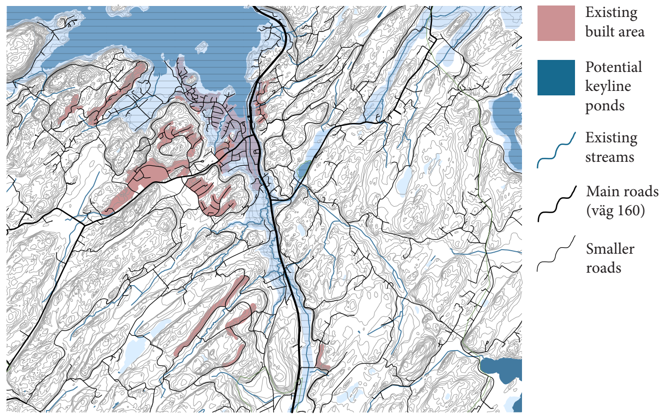
**1-2 Geography and climate change**
Up to 2-5 m sea level rise can occur already year 2100-2150 in case of high emissions and +5-8,5° warming. Even if we limit global warming to +2°C a rise of 2-6 m can happen in 2000 years according to IPCC (SMHI, 2022).



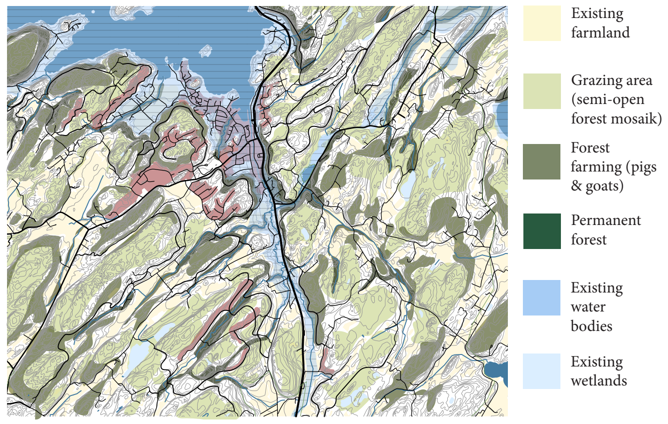

**3-4 Existing roads & built area under water**
Existing roads currently pass areas through areas with big flood risk or risk of being under water in case of 5-6 m sea level rise. So does existing densely populated "urban" areas which need to be adapted to higher water tables.



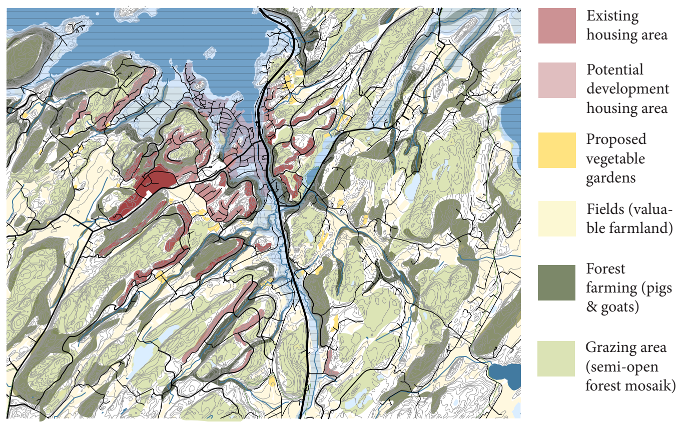

**3-4 Water & proposed new roads**
New roads act as alternative roads in flooding, enable biking/ walking and avoid obstracting farmland. Overlayed with existing built area and rising sea level. New small roads make the whole area accessible in case of high water levels or extreme weather.



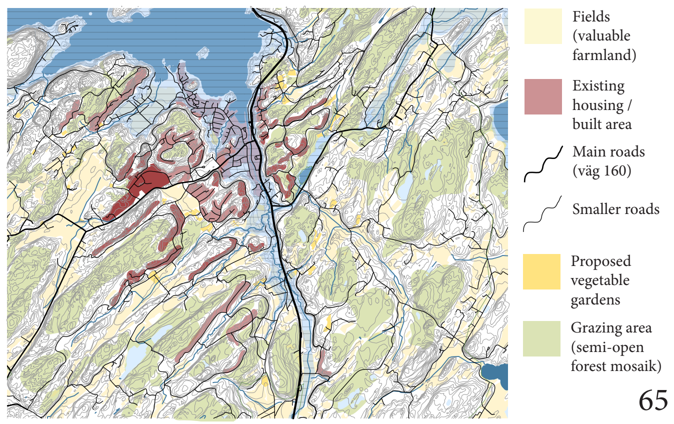

**5 Agroforestry and open field farming**
Forest shelterbelts such as riparian buffers along creeks and steep valleys protect from water erosion (trees between farmland), grazing and forest farming is located on slight slopes and open fields are placed in on protected fields with flat land.




**6 Potential new building area**
As the population of Orust doubles (Scenario B) - Henån could likely grow to 15 or even 30 thousand inhabitants. To prevent loss of valuable farmland new housing developments concentrate on hillsides along new main roads. In flooded areas up to 8 stories are built with adapted bottom floors.




**7-8 Farmland protected in new building development**
Land divisions (7) for new built areas follow landform (watersheds) and new roads. These divisions make up farming areas where the farmer can have control of the complete watershed. The most valauble farmland (open fields) are kept open and new areas are opened up via grazing animals and pigs/goats to regenerate the forest. All these farming & grazing practices regenerate soil (8).



## *Zoom in Case 2 - Vräland*

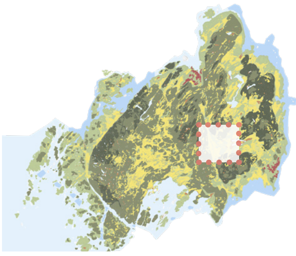
### Rural node growing into small village of food production

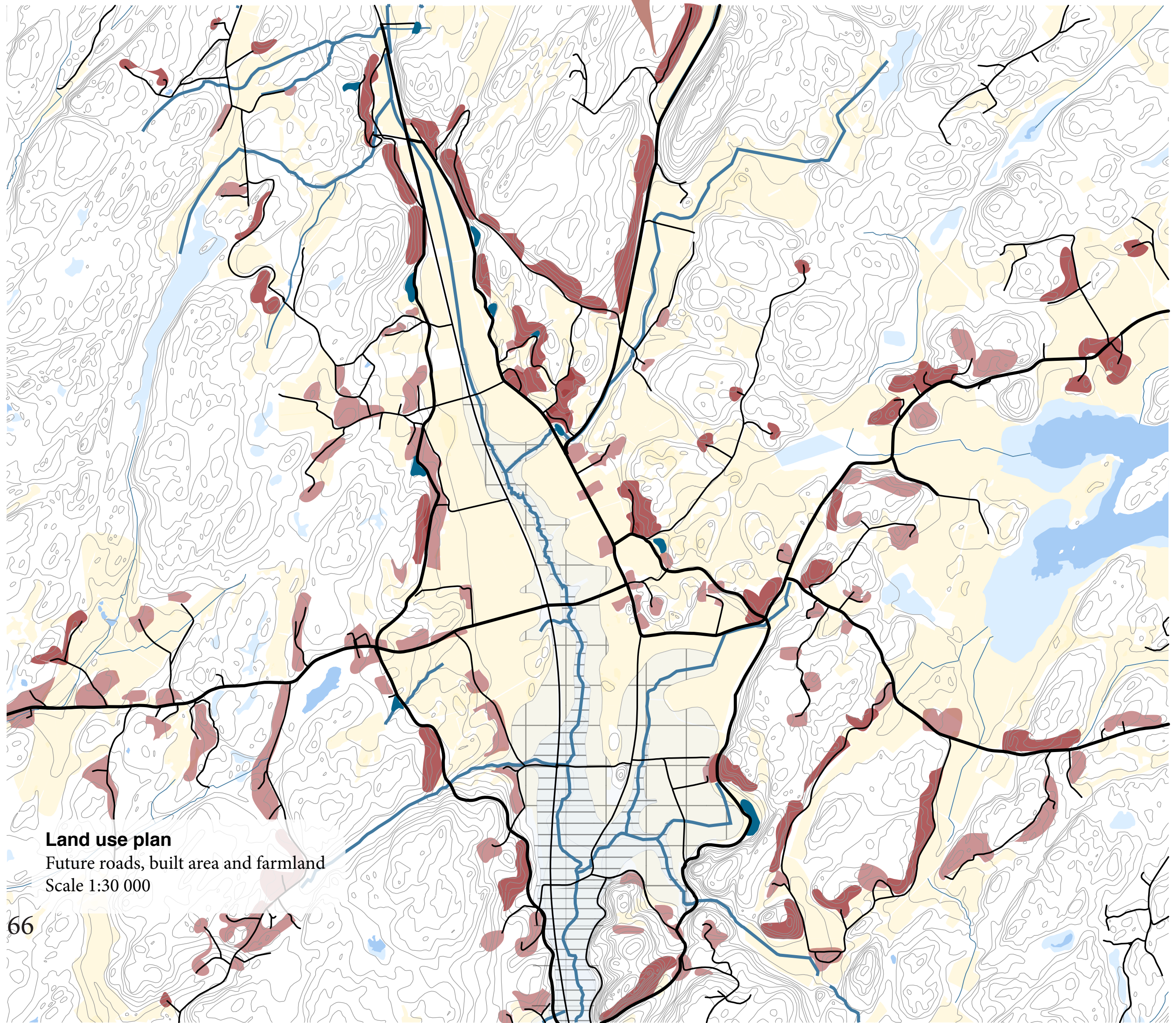
**An agricultural area and infrastructure node connecting Svanesund, Varekil and Henån** is proposed as one of the rural nodes for service and infrastructure - along the major access road between key "urban" areas Henån and Varekil (proposed as urban nodes for expansion). It is likely that the service and public transport nodes will also increase building of housing in the area and instead of letting new building "just happen" (resulting in urban sprawl on existing farmland) along the existing road I did an exploration to replace roads and propose new areas of building development according to the keyline scale of permanence.

*Why move from a straight road to a winding road?*

*Well there are many reasons:*

1. *To allow roads to catch and store water instead of leading it to undesired sites*
2. *To protect the farmland from urban sprawl and place services here*
3. *To avoid flooding the roads during heavy rains and sea level rise*
4. *To provide a complete network of bike and walking roads connecting urban areas.*



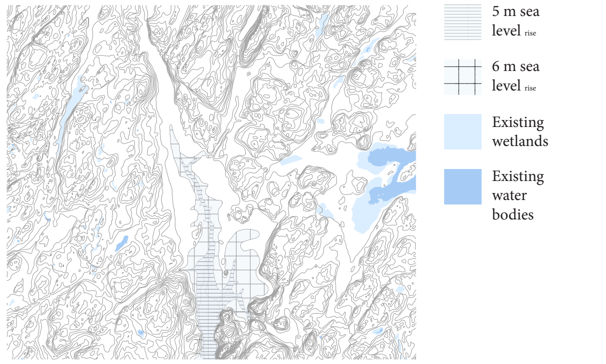


**Land use plan**
Future roads, built area and farmland
Scale 1:30 000

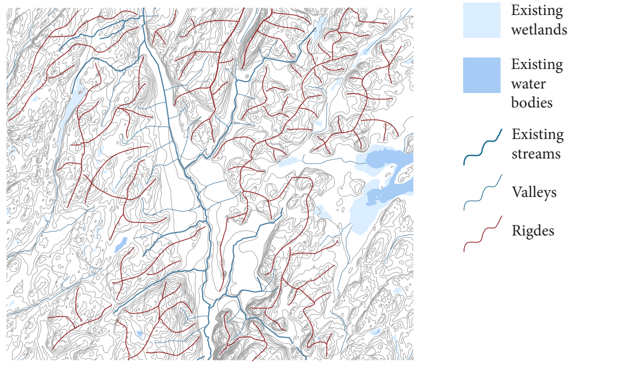




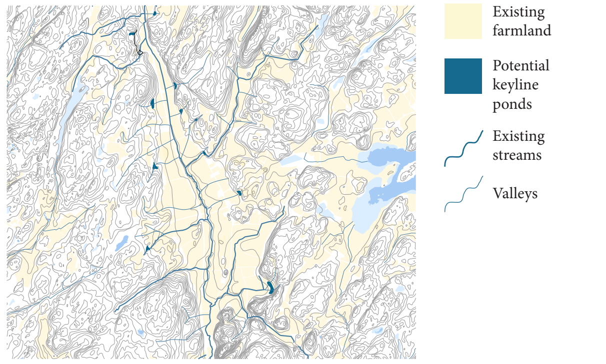
**1 Climate change and 5-6 m sea level rise**
The potential 5-6 meter in sea level rise might happen in the worst case IPPC scenarios (SMHI, 2022) would mean almost half the land in the valley will be under water. This might also happen in extreme rainfalls (f.ex. 100 year rains).



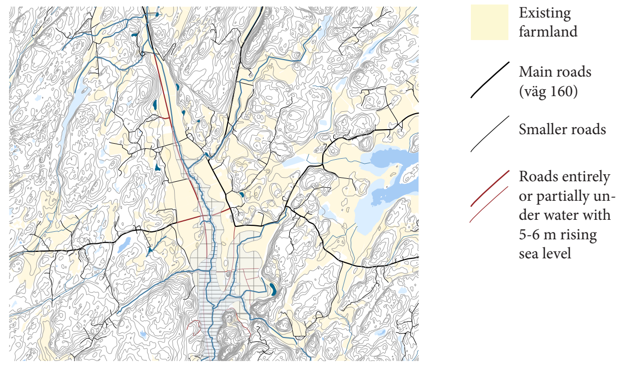

**2 Geography - ridges & valleys**
Main elements of the landscape determining water flow and where to place roads, buildings etc.



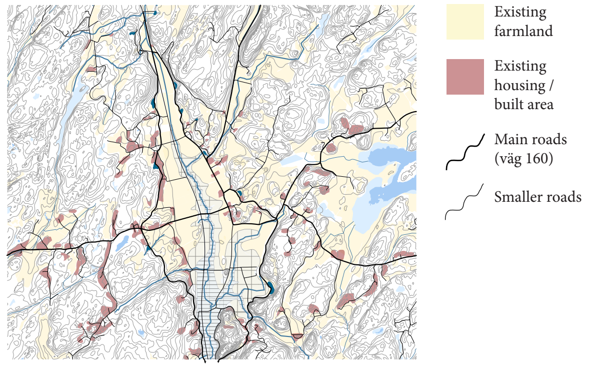

**3 Water & proposed keyline ponds**
Overlayed with existing farmland



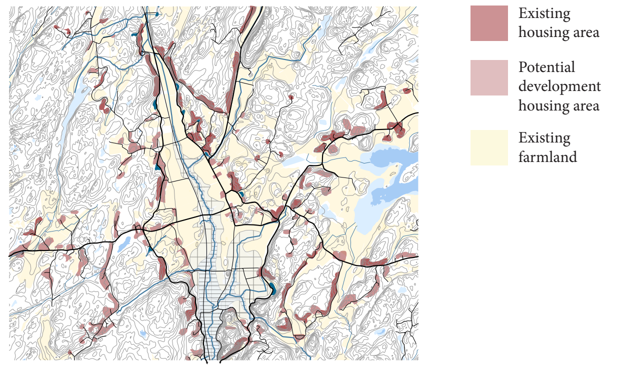

**4 Existing roads under water**
Existing connecting 3 major urban zones roads passing in the middle of valuable farmland and are all in flood risk or risk of being under water in case of 5-6 m sea level rise.




**5 Existing houses & proposed new roads**
That avoid flooding and obstracting farmland, while also better connecting existing buildings.




**6 Potential new building area**
As the population of Orust doubles (Scenario B) this "rural node" will likely experience growth. To prevent loss of valuable farmland new housing developments concentrate on hillsides along new main roads (where soil and topography is less suitable for farming).



*Let's explore the planning strategies!*

**What did we learn from this design research?**

Now that we have explored various contexts and scenarios from a farm to municipality or even the whole region. What are the "take aways" for planners?

There are quite a few key findings from all design explorations and they all show the significance of certain methods and frameworks for design and planning that I explored and that, I argue, must be practiced in order to achieve a regenerative food system and carbon positive food regions.

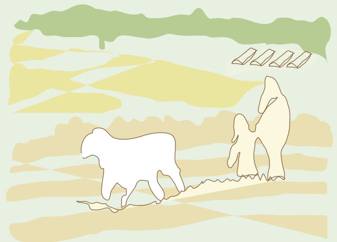
**The key findings are summarized in this chapter.**

It's a kind of manual for physical planners in form of the following six regenerative planning strategies.

# 3.4. Planning Strategies

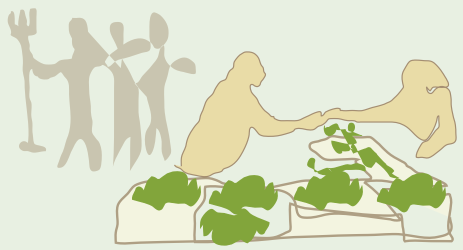
1.
*Co-create a holistic context & vision*

2.
*Holistic land use planning*

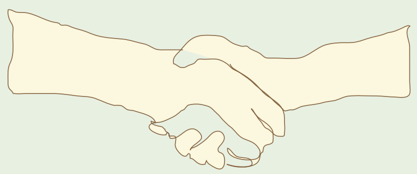


3.
*Farmland protection & food system planning*

4.
*Improve ecosystem processes & build soil*



5.
*Food nodes, markets and meeting places*



6.
*Funding & co-learning for regeneration*

# 1. Creating a holistic context

## *A common vision as the basis of planning*

### The foundation of decision making for a regenerative future

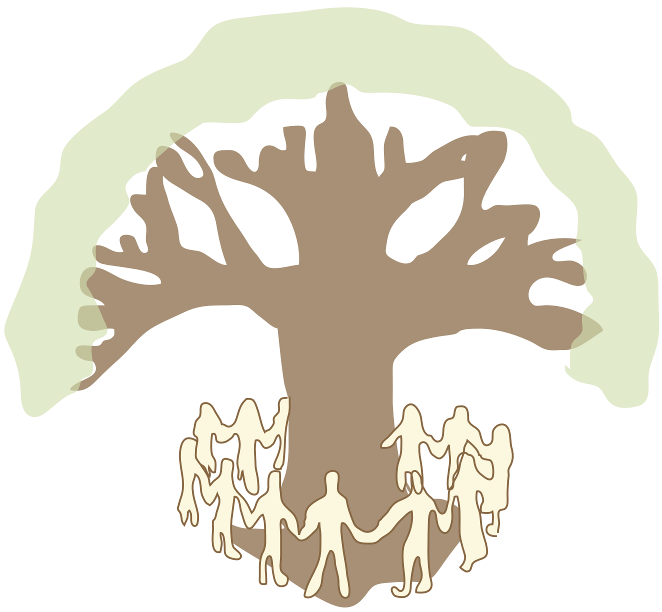
As mentioned in previous chapters when introducing holistic management the tool of creating your personal, business or even institutional holistic context is the foundation for articilating a clear direction and vision that underpins all decisions and can ensure they are are benefiting all species inlcuding both future and current generations. In order to regenerate both ecosystems, social relationships & communities and local economies this holistic context is a foundation. So in order to understand and apply holistic management on physcial planning I will now introduce the methods and adapt them to the context of municipal comprehensive planning or even regional planning.

Often municipal or regional visions are not truly considering the life of all current and future beings and neither are they based on a collaborative process of co-creation. In order to engage all inhabitants of Orust in co-creating a regenerative food system on the island, f.ex. both farmers, consumers and public actors need to be involved and ideally sharing a common vision and holistic context. So in order to create this context what shall a municipality do?

### Comprehensive planning - a continous co-creation and iteration

All municipalities use the tool of comprehensive planning to create an overall vision and direction for the land use and development in the whole municipality. This is often the basis for decisions of zoning plans being approved or not around new building projects, placement of everything from new housing developments to wind power plants. So in essence, this works like the holistic context and vision for the long term development of the municipality.

Today the comprehensive plan is often not updated very often, and it is often not considering all current and future beings inhabiting the local area. Creating a comphrehensive plan requires a dialogue with citizens which also makes it a slow process. However this co-creation process is vital if every inhabitant of the municipality shall be able to share this vision and by asking the right questions we can trigger ourselves to look at not just those currently present "around the table", but all human and non human actors who will be influenced by our planning and land use long term.



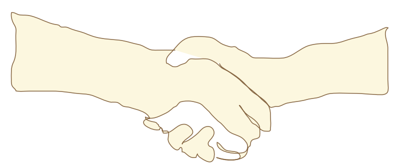


# 1. Creating a holistic context

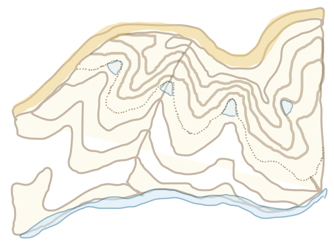
## *Co-creating a holistic municipal comprehensive plan*

### What are the steps needed for holistic comprehensive planning?

1. **A municipal holistic context:**
   **Dialogue process to create a holistic context**
   The first step in formulating a vision and holistic context is to identify all stakeholders and who are the decision makers. As "food system design" is a collaborative process driven by daily decisions of land owners, farmers, consumers and planners - they all need to be involved to co-create a common holistic context.



2. **Formulate strategies & plans:**
   **Defining a common action plan & strategy:**
   When there are strong relationships between the decision making actors and we all agree on a common context - a strategy and comprehensive plan can be created guided by this context.



3. **Decision making framework:**
   **Use context checks when making decisions:**
   When planners make decisions on behalf of all stakeholders/inhabitants they can use the "*context checks*" to ensure decisions are aligned with the common holistic context.

## Step 1: A municipal holistic context

1. **Wholes under management:**

   1.1. **Resource base: What "whole's" we are managing?** Physical resources, people, money or other types of capital:
   *F.ex. the land and ecosystems in the municipality, local food supply /systems, land use planning strategies, public health.*

   1.2. **Who are the decision makers?**
   *F.ex.land owners, farmers, consumers and physical planners.*

   1.3: **Other stakeholder:**
   Who influences or is influenced by our management - our land use & farming?
   *F.ex. public institutions, regulators at regional & global level, all species and generations.*

2. **Quality of life statement:**
   Who are we as residents of this place and how do we want our life to be? How will the landscape and society be shaped from our decisions?

3. **Future resource base:**
   "What will our land have to be like 200 years from now if our great great grandchildren to live have the same quality of life that we want?"

*Allan Savory*
(Palmer, 2020)

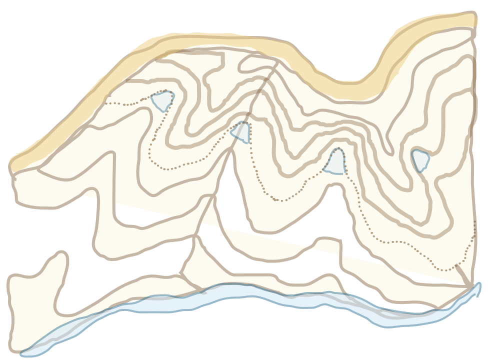
Adapted from material of Savory institute (2020)

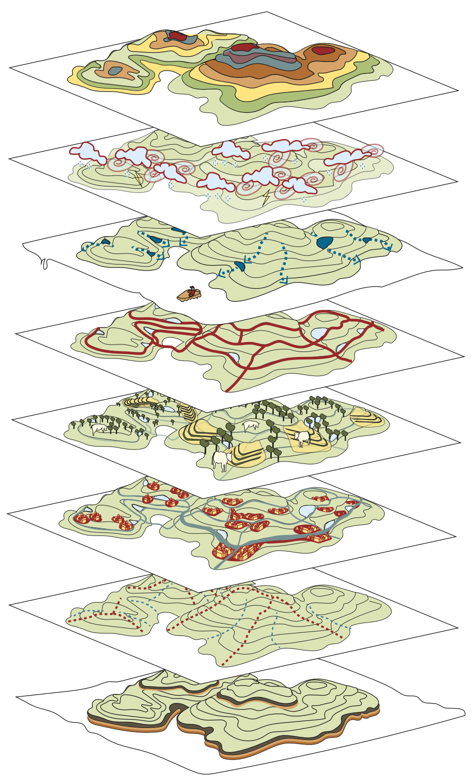
# 2. Holistic land use planning

## *Geography and water as the basis of planning*

### Physical planning inspired by nature and keyline design

When placing infrastructure, buildings etc in a comprehensive plan it is key to ensure roads and buildings will not be eroded during heavy rainfall and storms, this can be done by following the Keyline scale of permanence and understanding keyline geography. I introduced these things in chapter two (page 23 -24). But below follows an adapted version of Keyline design and its implications to be used in comprehensive planning.





## *"Holistic planning principles"*

**inspired by the Keyline® plan**

(Yeomans, 1958)

**General principle:**

*Plans shall follow the scale of permanence.*

By structuring the comprehensive plan according to the scale of permanence we ensure that the most permanent aspects of a landscape informs the placement of less permanent aspects.

1. **Use of geography and topography as the basis of all planning**
2. **Use microclimates and adapt to a changing climate**
3. **Catch, infiltrate & store water in optimal places**
4. **Place roads according to water flows and topography**
5. **Agroforestry systems to protect sensitive areas from erosion**
6. **Placing buildings & residential areas in correct places**
7. **Watersheds as land division units and border lines.**
8. **Build topsoil (capture carbon) & protect agricultural land**



# 2. Holistic land use planning

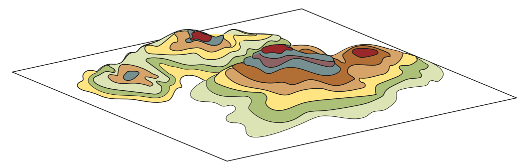
## *Exploring keyline physical planning strategies*

### Let's take a closer look at these eight strategies

In order to fully understand how we can implement this way of planning I will go through each of the strategies described on the previous page one by one and exemplify them by using some illustrations of each layer in the keyline scale of permanence.

## *Eight principles of reading the landscape:*

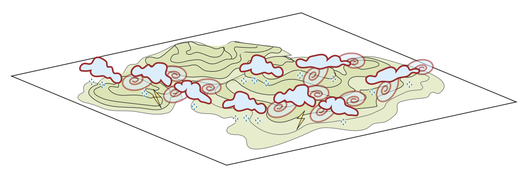
**1. Geography**



**Use of topography as the basis of planning**

By reading land geography and identifying the main and primary ridges and valleys of a landscape we learn where to place all the following layers. Learn to read landscapes and use the tools of keyline design in small & big geographies to understand water flows and let this inform planning.

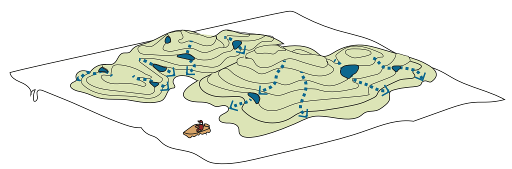
**2. Climate**



**Use microclimates and adapt to a changing climate**

Identify warm or cold microclimates where people, plants and animals thrive and vice versa and plan for increasingly extreme weather events.

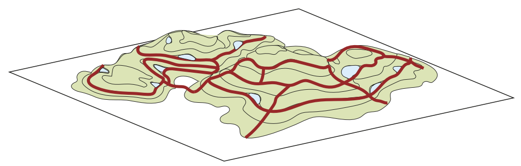
**3. Water**



**Catch, infiltrate & store water in optimal places**

Use keyline planning to identify key points in primary valleys as optimal places to store water as high as possible to gravity feed the lands below.

**4. Access**



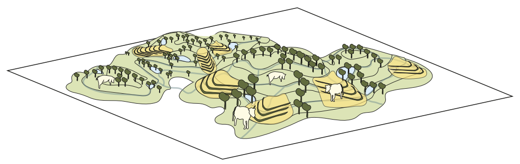
**Place roads based on water flows and topography**

Placing roads along countours of ponds to harvest and divert water here or on ridges to avoid flooding and erosion problems and ultimately save costs of road maintenance. The roads will have less damage and water catchment is turned from a problem to a solution.

# 2. Holistic land use planning

## *Exploring keyline physical planning strategies*

### 5. Agroforestry

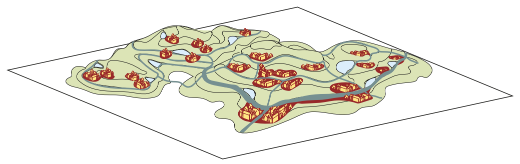


### Agroforestry systems to protect and regenerate

By placing agroforestry elements in the correct places we can protect landscapes from erosion and also create corridors for wildlife habitats.

*F.ex. planting riparian buffers (tree and bushes along water bodies) in steep valleys and creeks we can reduce erosion risk, reduce nutrient runnoff, increase biodiversity and overall ecosystem health.*

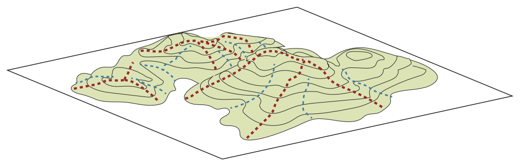
### 6. Buildings



### Place buildings & residential areas in correct places

We want to place our buildings and villages/towns in areas that will not be flooded, where houses can be appropriately heated by the sun, yet also can have access to both water (ideally by gravity from ponds), farmland for food supply and forests for recreation. This ideal location has been suggested by keyline designers to be at soth facing slopes where the landscape shifts from steep to flat. This in turn is informed by placement of roads and ponds (see point 3 and 4).

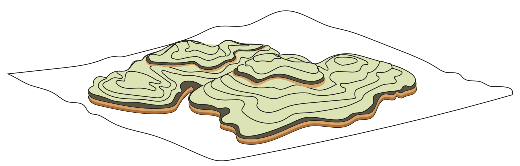
### 7. Subdivisions



### Watersheds as land division units

Since a watershed naturally draws a line of influence where your management on the landscape higher up will have consequences below, land division along watersheds makes sense. Also in a small scale watersheds since farmers then have more influence on the complete area influencing their land.

### 8. Soil



### Build topsoil & protect agricultural land

We currently loose topsoil much faster than it is being recreated, and as the basis of our civilisation it needs protection. Planning strategies shall set goal to increase topsoil creation which also captures carbon and could offsett some of the emissions in a local/regional carbon budget.



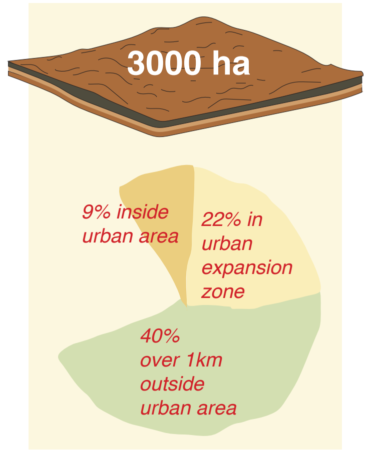
# 3. Food system planning

## *Protect and plan for future farmland to feed a growing population*

### Farmland protection:

Our farmland is farmland for a reason. Rich soils developed under tens of thousands of years is the foundation for our food production. If we continue to build houses and shopping malls on our farmland at the rate we did in Västra Götaland and Hallands län the last 5 years, we will loose 8-18% of all our farmland in just 50 years. Both Sweden as a nation, all regions and each municipality needs to develop frameworks to protect both existing farmland and potential farmland.

With an increasing population potential farmland (of different kinds) needs to be investigated and mapped out to ensure we can feed a future population. This means we need to make clear strategies on where to build and in case we must build on farmland to safely move valuable topsoil. We shall also create zoning plans where farming can be incorporated into the plans before, during or after the life of the buildings or diverted back to farmland.




*3000 ha of agricultural land was built on in Sweden during 2016-2020 (Tengby, 2021). It has been at that level for the past 15 years (SCB, 2019). According to Statistics Sweden's report from 2015, 40% of this land was over 1 km from the urban boundary and only 9% was within the existing urban area, 22% within the expansion zone. (ibid)*

*In other words, this depends a lot on what is called urban sprawl. If we had planned so that only existing urban areas as well as carefully selected expansion areas were built on, could we perhaps avoid losing valuable agricultural land?*

### Food system planning

Ensuring future land use needs and not just the present is key to have a long term resilience and "sustainable development" for both current and future generations. Therefore we need to make municipal and regional land use plans where we calculate potential future population growth and use scenario planning to create several scenarios of land use that will be able to feed these populations in these alternative futures depending on what people eat and how much of the food is produced locally and regionally.

Food system plans can incorporate farmland protection and shall be incorporated into comprehensive plans or as strategies such as in-depth comprehensive plans (that can span over several municipalities), local/regional food strategies etc. But we need to dare to ask the hard questions like the questions below.

### QUESTIONS FOR PLANNERS

- *Can we feed ourselves in crisis (f.ex. a war or pandemic with import stops)?*
- *How much of our own food do we need to produce, within our municipality, region and nation to be resilient to crisis and reach our holistic vision and the Agenda 2030 goals?*
- *Which scenarios of population growth here could happen due to global crisis and unforeseen events?*
- *How much farmland do we need per capita as a minimum and how can we plan for a diverse regenerative agriculture which also vitalises ecosystems?*

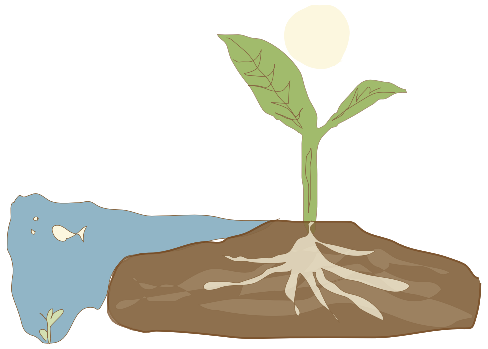
# 4. Improve ecosystem processes

## *Build healthy topsoil and vital ecosystems*

### 4.1. EOV - a tool to monitor ecosystem processes

The 4 ecosystem processes (mentioned in chapter 2) are the driving forces behind overall land and ecosystem regeneration and vitality. We can measure them over time by using the tool called EOV - ecological outcome verification - in order to know we have a regenerative (positive) outcome rather than a degenerative (negative) outcome. By doing scientific measurements to set up a baseline and then long term follow ups every 5 years along with short term monitoring every year that the farmers/managers can do themselves we can see if each of the processes improve and the health indicators of land increases or not giving an indication on how the land is regenerating over time and thus how well the landscape is building biodiversity, topsoil, water holding capacity etc.

**Municipal EOV monitoring can tell how land regenerates:**
As a basis of planning and municipal/region land use strategies we can ensure land and ecosystems are regenerating by using EOV to set a baseline and follow up with measurements every 5th year and planners or land managers can learn the yearly short term monitoring - to ensure land use is regenerative. This has been done on the island of Gotland by ecologist and HM practioner Gunnar Thelin and others. With the aim to improve the soils and thus capture carbon as well as infiltrate more water the entire island could become water positive and maybe even carbon positive by increasing soil organic matter from 4% to 8% we can capture carbon equivalent to 58 years net emissions from Cementa (Thulin, 2022). With the doubled soil organic matter, 113 million cubic meters of water can be stored in the soil. This is twice as much as the negative water balance from run-off and evaporation on Gotland today (ibid).



### 4.2. Close nutrient loops by catching excess nutrient in lakes & oceans

An important part of biodiversity and ecosystem health in both land and water is ensuring a balance of nutrients and the current overuse of syntethic fertilizers on cropland and also concentrated manure from animals leads to eutriphication. To solve this we need to close the loop of nutrients (N & P) which can be done by growing mussels (Lindahl, 2010). Also algea farming can revitalise water ecosystems, while also capturing carbon and nitrogen and phosphorous to be harvested and close the nutrient cycles our food systems. Read more in the appendix "The future of farming". Also wetlands and riparian buffer zones in water streams can capture excess nutrients anc capture it via biomass.

**QUESTIONS FOR PLANNERS**

- *Can we use monitoring methods like EOV to set a baseline of our agricultural soils and then follow this up over time? Who will be responsible? Employees such as municipal biologists? Can we set a budget for improving these processes?*
- *Wan we quantify the costs of negative spirals with ecosystem processes?*
- *What can we gain through positive spirals in the ecosystem processes? (soil carbon, water retention & drought tolerance, reduced flooding, nutrient filtration, biodiversity, clean water, clean air). What is it worth for current/future generations?*



# 5. Food markets & distribution

## *Can we support local food producers and optimize local distrubution through food nodes?*

### How can municipalities boost the local food markets?

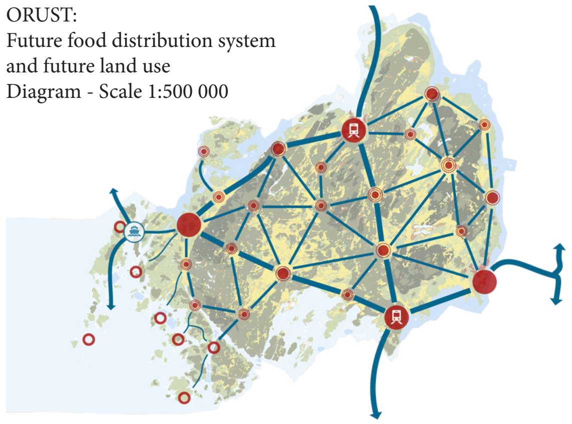
How do we create market places where consumers and producers can meet and food can be distrubuted efficiently over the whole municipality? One option is local food nodes within walking distance from each community. As suggested in my design proposal for inspiring Orust municipality's new comprehensive plan (ÖP) I propose a decentralized network of food nodes between towns & rural hubs. To provide the infrastructure for distrubuting the local food via foot or bike they are placed every 5 km or so. The key for efficient distribution is close proximity and for the whole food system to work the mental distance needs to be low between farmers and eaters.

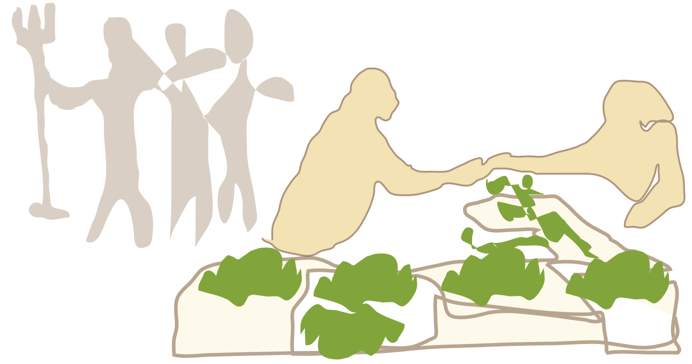
The food hubs can be coordinated with the rural transportation nodes similar to what is suggested in the new Orust comprehensive plan with more added to make distance closer between consumers and producers and creating an even more decentralized structure where local markets and food hubs is close to everyone in the whole municipality.

### Educational farms plays a key role

Creating meeting places for learning about local food is key and this can be done via urban or rural community gardens where people can come together. Garden collectives (tillsammansodlingar) play a key role as it triggers learning and conversation between consumers empowering them to become co-producers. Therefore urban or semi-urban agricultural land needs to be protected and planned for this function and a community garden or commercial "rurban" farm in each village or neighborhood can help shorten the distance between food production and consumption and can also act as the very place through which rural farmers reach out to city dwellers with their produce.

ORUST:
Future food distribution system
and future land use
Diagram - Scale 1:500 000





**QUESTIONS FOR PLANNERS**

- *Can transportation hubs and nodes in the rural areas connect consumers and producers by providing an infrastructure to distrbution of local food?*
- *Can community gardens and urban/rurban farms act as meeting places to connect rural farmers with the urban population?*
- *Shall the urban area (tätort) be the centers of human settlements or rather a decentralized structure of towns with inhabitants more equally distributed?*
- *Will it be easier to provide local food to supply urban areas if they are reduced in size to maximum 30 000 inhabitants? What if they are even smaller, like 500-1000 inhabitants?*

# 6. Funding & co-learning

*"Accelerated topsoil formation is the work of our time"*

*Abe Collins,* (Schwartz, 2013, 1 h 20 min)

### Funding is key but complex

In order to shift more farmers to regenerative practices that sequester carbon and build healthy topsoil and ecosystemens we need to make sure farmers and land managers can be payed for the carbon they sequester and the ecosystems services they regenerate. Since farming today is not a very profitable venture (even if renegerative agriculture proves more profitable the food prices are still to low to pay the farmer for the true value of their land regeneration) this would help farmers make a living, however there is a risk that farmers need certifications to prove they are regenerative - which in turn is costly and might lead to more global governance around "carbon farming" where middle hands and bureacracy wants to get a part of the profit and economist Maria Ehrnström-Fuentes (2022) believes in stories rather than certifications .

### Monitoring and funding regeneration

However the EOV-monitoring tools developed by Savory institute (2020) has proved to be both affordable and based on the fundamental idea that regeneration is not a method (which many global and regional definitions claim) but an outcome where ecosystem processes improve over time (see strategy 4). It can be measured scientifically and observed by anyone who is trained and thus the effect of regeneration can be proved - meaning that land that is regenerated over time can prove to be actual carbon sinks and thus the land managers could be payed for this regenerative land stewardship. This can inform country administrative boards farm funding, policies, foood procurement in municipal and public kitchens.

### Awareness and paradigm shifts

The transition into regenerative land management requires not just funding but also a shift in mindset and perceptions on how we do things. This might in fact be the biggest hurdle to shifting the way we farm or manage land - as new methods and ways of thinking can meet resistance to change. In systems theory Harich (2010) describes "resistaince to change" as the root cause of not being able to solve our current problems in the sustainability realm. Another system thinker Meadows (1999) describes the paradigm shift as the most effective leverage point to change a system - but also the hardest to change.

### Co-learning is the way forward

If we are to truly achieve carbon positive food regions a broad set of actors need to be involved: both top down actors such as physical planners and public instititutions, farmers and land managers working on the field, businesses, civil society, academic actors etc. They all provide unique perspectives and have unique knowledge informing the co-creation of truly regenerative food systems and future societies. As mentioned in the first strategy (a holistic context) all actors need to be involved in creating a common vision, but it is also key that the co-creation process continues as it also produces co-learning and knowedge for all involved parties. The "second generation" of *backcasting* is defined by Robinson (2003) as a co-creation of the desired vision, not determined in advance but emerging from the engagement with users. This form of *backcasting* process can contribute to "social learning about potential and desirable futures" (ibid). This tool is a great way to provide a type of co-learning that might even shift paradigms as several potential futures can be considered.

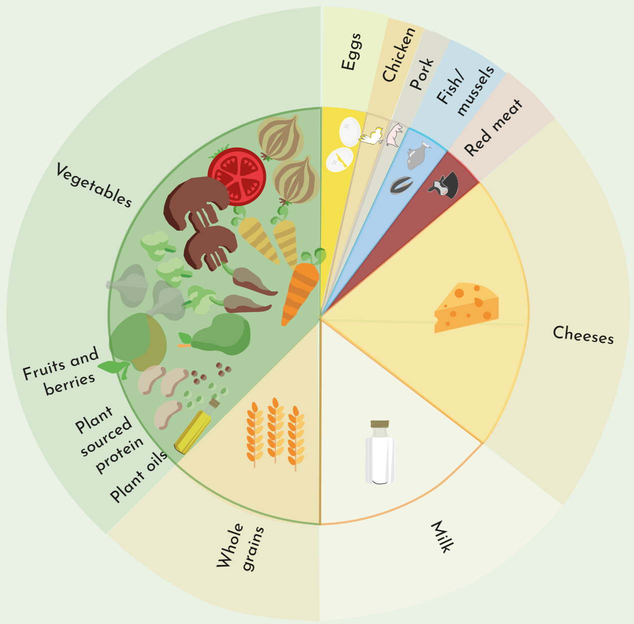
**QUESTIONS FOR PLANNERS**

- *Can we support regenerative farms through food producement in pubilc kitchens?*
- *Can we incorporate soil carbon sequestration in our carbon budget, potentially offsetting some of our emissions? How can we then pay for the carbon sequestratioon cost to the farmer? Can we monitor land regeneration using the EOV-methods and then pay farmers for the positive changes in local procuments?*
- *Can we promote regenerative farming through renting our land to such management?*
- *Can we promote education of soil health and regenerative agriculture through school, academia and civil education (folkbildning)?*
- *How can we help raise awareness and shift paradigms from sustainability to regeneration?*

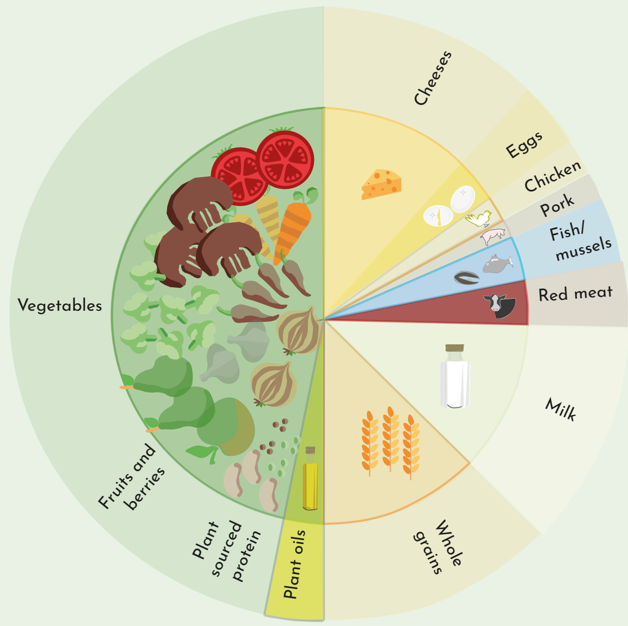


# 4. Discussion

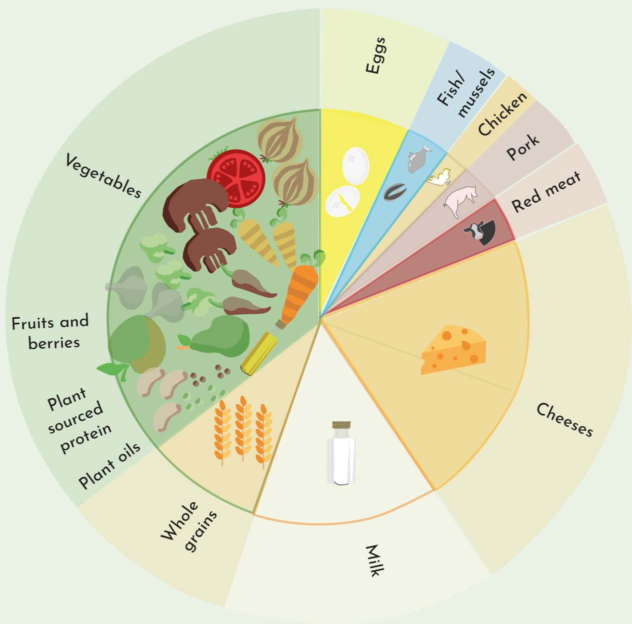
## *Reflections and implications*




Scenario A




Scenario B




Scenario C

# 4.1. Main insights - Principles

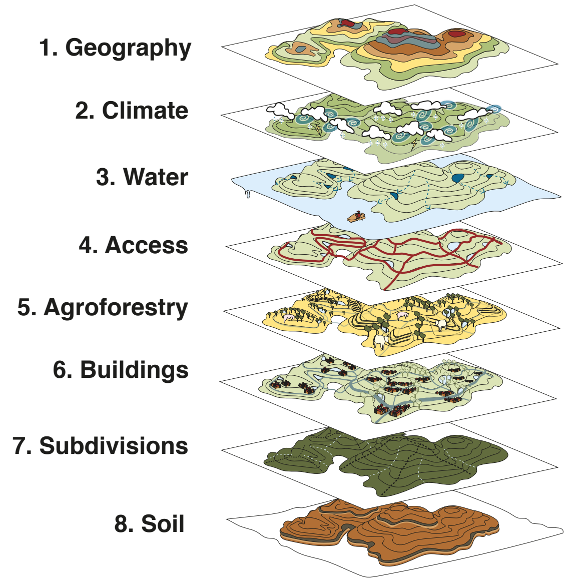
## The importance of the planning process

### Keyline planning methods for planners

The main insights derived from this design project and exploring Keyline design and planning in combination with a set of regenerative planning and design strategies on both the farm scale and the municipal comprehensive planning scale - are the importance of using such a comprehensive method for planning. Using the keyline scale of permanence and letting geography and water inform roads, buildings and farm placements on both Bjällansås farm and Vräland and Henån in Orust was gave many lessons and principles that can be applied for planners for more resilient and regenerative land use.

### Regenerative planning principles:

These lessons are summarized in my design strategies and include everything from ensuring food production for current and future generations and protecting valuable farmland as well as adapting to a changing climate with both extreme rain events, sea level rise and drought. Using what I call "regenerative planning principles" we can consciously steer the placement of urban sprawl through the placement of new roads that both catch and store water in the right places while allowing for service and infrastructure to be developed along existing routes.

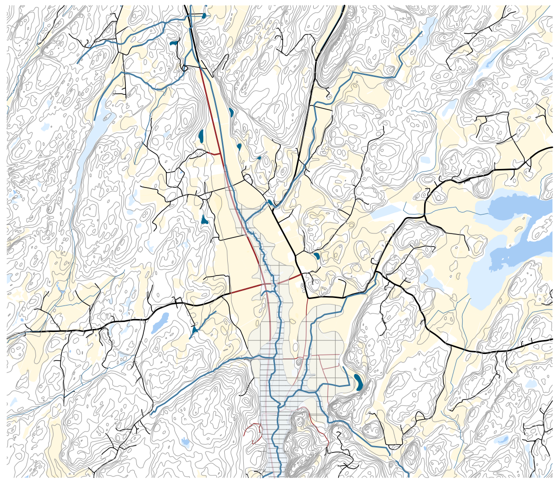



## Lessons on placing roads

### Diversifying existing infrastructure

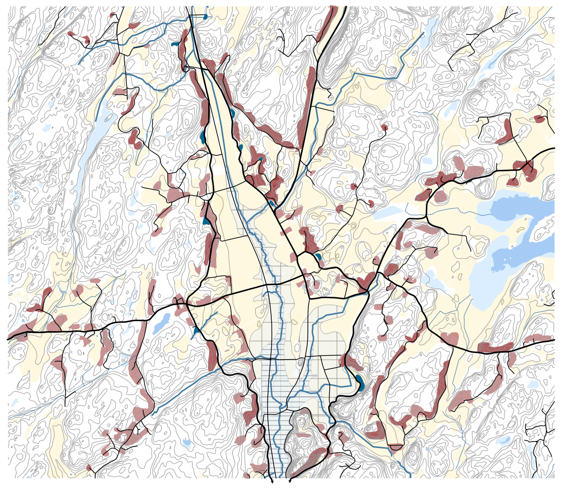
### A future where people and food travel by foot

Insights from Vräland in Orust are also the lack of biking and walking roads and how the existing roads only prioritizing cars cut through old roads that would be ideal for slower bike/foot traffic. In order to make the whole of Orust accessible by foot and bike these old road could be connected and provide safe infrastructure for the future's more slow traffic. Why do I believe the future is "slow traveling" - well frankly we need to cut our energy use so much that we need to decrease our car use a lot even if we would replace all cars and buses with electric automnous shared vehicles. And the public transport itsel is also more slow.



### Replace highways or complementary roads?

The question then is shall we replace existing high ways (landsvägar) with more winding roads that might better suit as bike or walking roads (GC-vägar) that could also allow public transport? Well even as the road 160 in the case of Vräland and Henån in Orust will be under water with a 5 m sea level rise in 100-2000 years in this future we might no longer need such a fast road and could lead all traffic to the slower winding roads along the forest edge.





# 4.2. Can we go carbon positive?

## Carbon positive - is it really possible?

*I made some calculations on Orust and Västra Götalandsregionen on what the potential carbon sequestration rate is per capita in the different scenarios of population growth. The findings are that it is possible to sequester more than we emit but we need to reduce our emissions to 1 ton/capita according the Paris agreement to have a good chance.*

### On a municipal scale?

*It's complicated and more research is needed - but yes it's possible!*

In my design research on Orust I gave examples on how in both scenarios a significant amount of carbon could be sequestered which in *Scenario A* would mean Orust could become carbon positive and have a net positive impact of +18%. This is based on a higher estimate of 11 ton/ha in $CO_2$ sequestration meaning all farmland needs to be practicing regenerative farming using agroforestry systems like silvopasture and silvoarable cropland (integrating trees on pasture and crop fields). With a doubled population in *Scenario B*, a shifted diet means tha same people can be fed on the same land use - and this dramatically reduced the positive impact of regenerative land use per capita as farmland per capita decreases. However in this scenario almost all consumption emissions could be sequestered, if emissions are halved from todays 9 tons to 4,5 tons according to the regional goals in VGR (2022).

### If sequestration rates are low we need more farmland per capita

Naturvårdsverket (2021) argues we need to reduce emissions to 1 ton net emissions until 2030 in order to reach the Paris agreement and limit warming 1,5-2 degrees. In this case even in *Scenario B* Orust could be carbon positive (even with lower estimations of sequestration at 3 tons $CO_2$/ha /year (which has been seen just by converting plowed field to no till pasture/grassland) according to studies by SLU and european trials. The conclusion? If emissions per capita are cut to 1 ton/capita, Orust could be carbon positive in both scenarios with a net sequestration of 1,15- 1,6 tons. However today sequestration rates are still estimated cautiously and many use numbers around 1 ton $CO_2$/ha /year. This would mean that sequestrations per capita would be around 0,46-0,66 (Scen B-A). In this case only *Scenario C* (the current population being self reliant with a meat consumption similar to today) would be the only case in which we reach net zero emissions by sequestering 0,95 ton $CO_2$ / capita. Since we cannot limit population growth in a world of wars and climate refugees I believe we must strive to keep up the number of available farmland/ capita and also strive to maximise carbon sequestration by using the principles and strategies presented in this thesis.

## Is it a feasible goal?

I think it is, but its not going to be easy. Although it will be the most practical and cost efficient way to avoid climate chaos while also reversing biodiversity loss, eutriphication and loss of topsoil and adapting to climate change as soil will infiltrate more water in droughts and storms.

### On a regional scale?

*What is needed to mitigate and adapt to climate change, as well as reversing biodiversity loss and dessertification?* We need to reduce all emissions /capita to 1 ton and increase regenerative farmland/grazing to 40-50% (as shown in chapter 3.1) of all regional land use. With a doubled population this would mean 0,5-1,2 ton CO2 sequestered /capita/year (with low estimates). If we transition all this agriculture to agroforestry systems and capture 11 tons / ha this would mean up to 4 tons/ capita (high estimates based on agroforestry). This means we might need less land but in order to feed the doubled population even with a meat consumption of 36kg/year (10-15% compared to todays consumption) we still need all this land.

**Orust net emissions**

**-3,13 ton**
emissions /capita
*= 170% of emissions sequestered*


*Scenario C*
*Illustration showing potential of to be 70% carbon positive!*

# 4.3. Who does what?

## *What change is needed?*

### Self reliant regenerative food regions - who does what?

The theory in chapter 1 & 2 with future challenges of global crisis events related to food make it clear that increasing our self reliance while also improving land and ecosystem vitality. My design explorations and discussion on previous pages has shown that that we now know it is possible and necessary to become carbon positive. We also know we need to increase our food production by transforming 40-50% of our regional land use to regenerative farming and grazing.

*The question is what is needed and who does what?*

### Can bottom-up and top-down actors co-create these food systems?

I wrote in chapter 2 about collaborative food system design and how I believe that consumers shape the food system with their daily actions and how the planner can be a collaborator in this process by enabling a shift to regenerative farming, eating and land use. Ultimately we shall form coalitions to design our regional or municipal food systems with a combination of top down and bottom up strategies. After all the farmers transitioning to regenerative practices is the first key step along with consumers requesting regeneratively raised meat and vegetables.

## *Who needs to do what?*

### The role of the region?

*What role does the subregion Fyrbodal have and the bigger region VGR?*

Regional planning needs to include land use and food system planning to support regenerative agriculture. The 2021-2030 regional planning strategy (VGR, 2021) does not even mention food or land use in the main strategies. While the regional food strategy (Lst VG, 2018) mentions the important challenge of scarce farmland, the need to shift to an agriculture with positive impacts, and less depence on fossile fuels (which could all be subsumed by the goals of a potential regenerative food strategy) no real sharp targets are set on farming and land use. The Västra Götaland län (Lst VG) also needs to remove existing barriers for regenerative farming and land use. To summarize:

*Västra Götalandsregionen need to:*

- *Sharpen the regional goals to include targets on how much agricultural land we actually need to feed the population*
- *We need physical planners actually working on regional food system planning. Employ regional architects and food system designers to coordinate land use planning using design thinking processes so there is someone leading the process*

*Länstyrelsen need to:*

- *Make it easier for Algea and Mussel farming to develop by removing some legal hurdles (like costly LCA's etc).*
- *Remove fees for the outdoor program (to facilitate for outdoor grazing in wintertime to increase adoption of these common regenerative grazing practices.*

### The role of municipal planners?

Implement the planning strategies in chapter 3.4, f.ex:

- *Integrate these strategies into comprehensive plans and zoning plans*
- *Co-create a holistic a context for multi-generational decision frameworks and let the plans & strategies be informed by this*
- *Create municipal goals to ensure farmland is protected and developed and support in regenerative land use shifts*
- *Use procurement of food to support local regenerative farms.*

### The farmers and consumers role?

- *Come together and unite around a common holistic context or vision (even if public actors don't initiate the process). It can even be done at a village scale!*
- *Form alliances of producers and consumers and to become a network of co-producers of the landscape*
- *Vote with your fork with every meal on the farms and food system you want by supporting local regenerative farms.*

A good example of creating a common vision is a report from Sveriges Klimatriksdag (2022) called "Farming in 2035" where they describe a future of primarily regenerative agriculture very similar to the one I illustrate in this thesis.

*Why do we need regional architects? Read more on the next page!*



# 4.3. The Architects role?

## *A need for regional architects and designers*

### The importance of the designer

As discussed on page 76 on the method of backcasting is a powerful design tool of co-creating desired futures and co-learning between top down and bottom up actors. *But who shall lead and coordinate this process of design exploration?* I argue it is ultimately a role destined for architects and designers to collaboratively design desired futures using the strategies presented in this thesis to *bridge the gap of time, scale and perspectives*. It will be the way to both connect the potential futures with todays strategies, connect various actors with each other under one common holistic context and also connect the various scales of design and planning. The architect has a key role in these design processes as we have unique skills to *visualize potential futures* and illustrate these scenarios and how they affect the physical environment, but also since we have experience in solving complex problems and creating holistic solutions considering many perspectives and scales. Architects rarely work in the regional scale or even the municipal scale as I have done in this thesis. But the future practice of *regional planning* I argue needs the competence of good designers using "design thinking" in collaborative processes where *design explorations* such as *backcasting* can be used to illustrate potential change stretching from the regional scale, municipal scale all the way down to a neighborhood, and building scale.

### Design thinking & co-creation

As a poweful process of empowering people to co-create solutions the common challenges the architects has a key competence sometimes called "design thinking". Design thinking expans on the notion of design as a method of knowledge creation and innovation that goes beyond discipline boundaries. It goes through the following steps of *Emphatizing* with the users needs, *Defining* the problem clearly, *Ideation* and creation of many possible ideas & solutions, *Prototyping* and *Testing* some of the solutions to get feedback on what works and finally *Sharing* the results. Much like how this thesis was carried out - including a variety of disciplines and stakeholders in the process. I have personally even used design thinking in workshops where children in disadvantaged communities in South Africa were empowered to become designers through this process. I saw their proud smiles and understood it's a process everyone can learn - but a well trained designer shall ideally be leading the process.

> *"What many people call 'impossible' may actually only be a limitation of imagination that can be overcome by better design thinking"*
>
> Richard Buchanan (1992)
>
> Professor of Design, management & information systems
> One of the early influencers using the term "Design thinking"

### We need food region architects!

Just like we have city architects, taking a holistic view of the built environment of cities and municipalities, I argue that *regional architects* and *food system designers* are needed to take a holistic view and coordinate local and regional processes of land use planning processes within and between administrative boundaries.

*I don't mean such an architect would be acting as "top down master planner" of a whole region - but rather there shall be architects working on connecting the different scales of planning using collaborative design processes and gather various stakeholders around the same tables.*

Perhaps regional architects could work both on municipal and subregional levels and *accross several municipal boundaries* when needed. They could be employed at the regional/county level or work as consultants across the scales and they could be respoinsible for *coordination between actors* and sectors that currently don't communicate that well. Maybe this could be the person responsible for *food system planning* and how we increase *self reliance on food,* ensure *net carbon sequestration* through land use planning while balancing other land use interests in dialogue and cooperation with a multitude of stakeholders.

# 4.4. Why is it not happening?

*With all the benefits of scaling up regenerative local food production - why hasn't it happened?*

*Now you probably understand all the benefits of local regenerative food systems and we also know it is possible and maybe required for us if we are to achieve booth climate, biodiversity and other sustainability targets. So why hasn't it yet scaled up?*

## Regional planning yet to come

*The gaps from just focusing on municipal planning?*

At the moment the regional planning is very limited as the municipalities have planning monopoly and this has its limits as the important inter municipal scale might be overlooked unless municipalities have resources to gather around common topics (like Tjörn & Orust's common "FÖP Hav" - focusing on the Ocean). This might lead to agriculture and land use issues on a regional scale to be overlooked as the issues at hand for municipalities might rather become how to expand housing or industrial developments, infrastructure etc. This is about to change and both Västra Götalands län (VG län) and perhaps also subregions like Fyrbodal komunalförbund will likely have more responsabilities to coordinate comprehensive planning strategies due to a new law passed by the government this has already happened in Skåne län and Sthlms län (Regeringskansliet, 2018). *But is regional planning enough? And why hasn't the region or VG län yet developed targets on agriculture related to land use? Well I suspect it is an infected issue...*

## Different land use interests

According to SLU researcher Magnus Ljung (2021), we live in an increasingly biobased economy and land use will be one of the main reasons for conflict. Venture capitalists are investing in land even from other continents (ibid) and there are capital interest in both material resources and potential land for industries (both needed for an electrified & biobased economy) and a chance for rural municiplaities to attract new jobs and hopefully turn a negative population trend and regional planners daring to set targets around land use has been left with lots of political resistance around the land use issue even being discussed in regional planning (Fredriksson, 2021). In terms of land use we have the four F's - the main forms of production which today sometimes stand in conflict; Food, Feed, Fiber and Fuel (Ljung, 2021) and apart from this the land is also needed for ecosystem services, housing, recreation etc. It is widely debated how problematic it is to produce biofuel on agricultural land f.ex. as it requires lots of the scarce farmland and even if we produce biofuel from forestry our current reliance on monoculture production has a big political and economical interests behind it (the entire wood and biofuel industry probably wants to keep or even increase the current "productive forests"). *How could these potential land use conflicts be solved?*

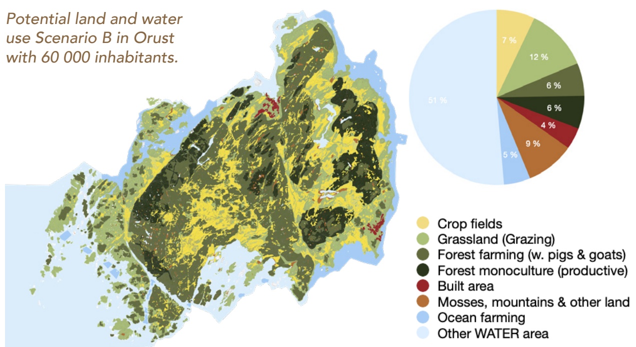
## What about the ocean?

*Well it is not just land use that has potential conflicts embedded there are also various interest of how we use our oceans and especially our coastline.*

As seen in the early version (samrådshandling) of the "in-depth comprehensive plan" (FÖP Hav) of Orust & Tjörns kommuner (2019) the proposals of new expansion areas for aquaculture is a lot more limited than what needs to be the case in order to supply the food and and animal feed needs. In *Scenario A/B & C* up to 45-70% (≈4500-7000 ha) of the coastline around Orust (≈10 000 ha) would need to be devoted to ocean farming but the current suggestions cover only about 2-5% (≈200-500 ha). The main conflict here is that the coastline is needed for both tourism and harbours, energy production, but also wildlife and recreation.

My conversations with Bohus sea culture (2022) also gave insights on the conflicting interest with the coastline defense. Many of these interest might be able to coexist, like recreation and sea and wildlife habitat which shall increase with algea or mussel farming and small scale farms might also be able to integrate well with tourism and harbours. Also wind turbines and defense areas along the coast I assume can be placed further out from the coast where ocean farms are less appropriate. So is it possible to scale up ocean farming as proposed in Orust? Well perhaps not just along the main coast and inland but some of it needs to be located further out as well, perhaps it can even be combined with the construction of new wind farms?

*Potential land and water use Scenario B in Orust with 60 000 inhabitants.*






# 4.4. Multifunctional land use

*Can we cater to all these interests and needs?*

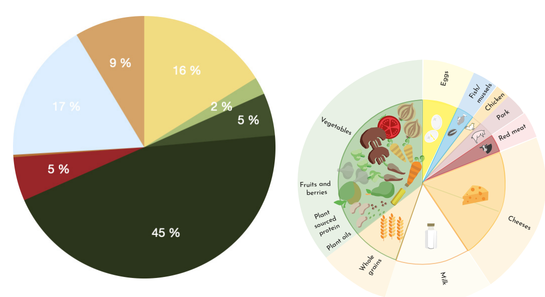
## What is the solution?

I argue multifunctional land use is the solution. I have explored futures where monoculture forestry decrease from todays 45% to only cover about 14-22% of the VG region in order to feed a population in in *Scenario A and B*, yet the landscape is likely to produce similar if not more biomass that could go to timber, fuel etc apart from food and animal feed.

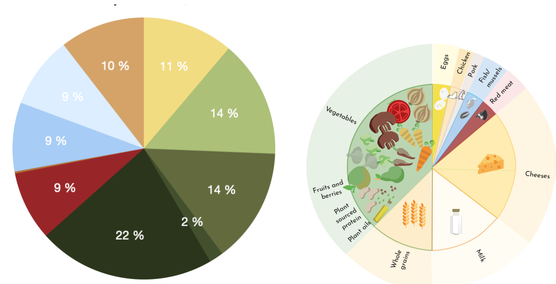
Ljung (2021) argues all the four F's can coexist in tha same landscapes along with recreation, ecosystem services and housing - but this requires a shift froom specilasation to multifunctionality, from global competition to local integration, from top down planning to co-creation and from incremental to transformative change. Researchers behind the latest EASAC (2022) report on regenerative agriculture claim that this form of production can combine profitable food production with biodicversity and carbon sequestration. Urban Emanuelsson (2021) a researcher european cultural landscapes argues in a report for WWF on how to both produce food and biodiversity that the three biggest low hanging fruits are grazing land (naturbetesmarker), wildlife shelterbelts between fields and wetlands (that can also be grazed).

This is very much aligned with the ideas presented in this thesis and the regenerative food producing landscapes I propose to cover 40-50% of the VG region are multifunctional landscapes with similar or more trees forests that are just more spread out in a mosaik patterns. The agroforestry methods I propose in this thesis is a great example of this - where shelterbelts along fields, recreated wetlands (where biomass can be harvested by machines or grazing animals) and riparian buffers along with tree rows in actual fields and forest grazing - all areas than can promote biodiversity and produce both food, feed, fuel and fiber. The main issue is that in this landscape it is less rational to harvest the timber and biomass at industrial scale like we do today. So perhaps we need a new small scale forestry, biomass and bioenergy industry that can transform all this into products of a regenerative and more decentralized bioeconomy?

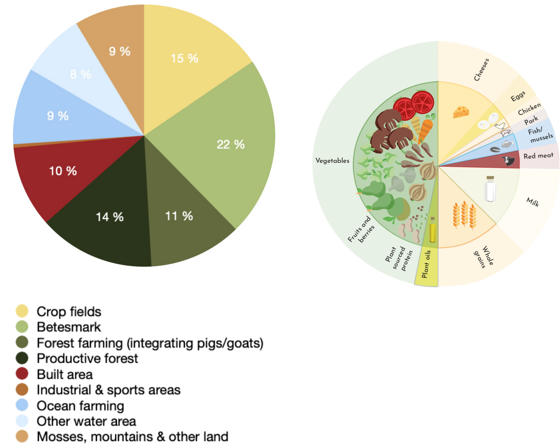
*Land & water use VGR Today (2015) with 2,3 million inhabitants and <50% self reliance:*

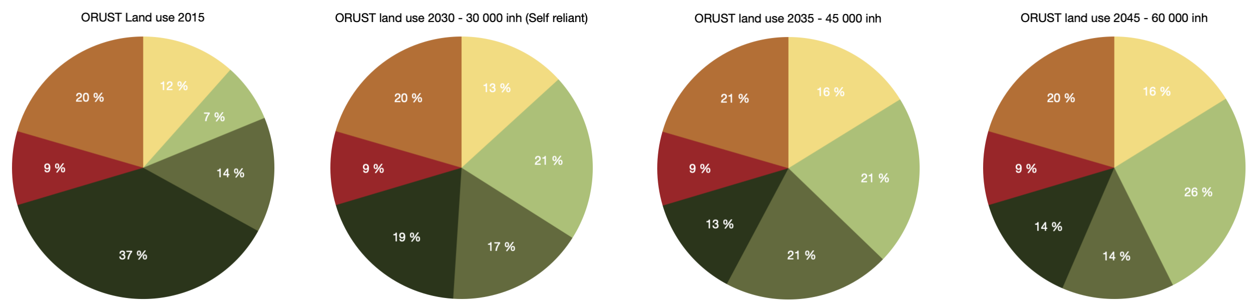



*Land & water use VGR Scenario A with 2,3 million inhabitants, 100% self reliance and this diet:*




*Land & water use VGR Scenario B with 3,6 million inhabitants, 100% self reliance and this diet:*




*Existing and potential land use in Orust. Left to right: Today (2015, Scenario C, A & B)*

## 4.5. Conclusions & summary

### Start with defining common values

I encourage the Västra Götaland Region and all municipalities to co-create their own version of a holistic context as a basis for creating common regional visions, strategies - and ultimately as a basis for decision making. This way we can include the quality of life of all species and both current and future generations in our measure of success.

I also encourage all of us inhabitants to make our own holistic context and come together to ask global policy to change to align more with this common future vision of regeneration rooted in a well defined and clear holistic context. when we come down to it we pretty much all share the same basic human values and needs (of food, water, shelter, education, transportation).

### Designing multifunctional landscapes

*We are all food system designers!*

The very act of eating shaping landscapes and food systems around us and so we can all be co-designers of these landscapes by getting to know our local farmers and thus becoming "co-producers". The planners ultimate role in aiding a transition to resilient food systems shall be to facilitate this process and make it easy for local regenerative food economies to grow. This requires setting ambitious goals of local production at a regional & municipal scale, removing obstacles and planning for our future needs for farmland by integrating "food system design" into our comprehensive planning. But as a planner you also need to balance complex interests and understand the importance of multifunctional land use (such as agroforestry landscapes) providing both food, feed, fuel and fiber while improving ecosystem health and vitality.

### Action items of physical planners:

- *Co-create a common holistic context and vision for the municipality and region* defining "quality of life" for all current and future generations of beings inhabiting the area. *See page 69*
- *Create comprehensive plans with sharp numbers and goals around food production* and regenerative land use based on the holistic context and food system planning.
- *Integrate regenerative planning strategies in comprehensive plans and zoning plans* (to point out best location of water, roads, farms and buildings (in the right order). *See page 70-72*
- *Monitor the four ecosystem processes on land over time and provide funding* to support to local small scale multifunctional regenerative farming, ocean farming and agroforestry practices that increase ecosystem vitality, biodiversity, soil fertility and resilience towards climate change.
- *Create a municipal and regional (transmunicipal) food system planning documents* as an integration of the comprehensive plans and local food strategy (f.ex. regarding local food supply in times of wars, crisis, closed borders, etc.).. This shall include:
    a) Numbers of existing and potential inhabitants and their consumption in future scenarios.
    b) Land use needs to produce food for these inhabitants in different scenarios of self reliance.
    *Like Länstyrelsen i Värmlands län did you can create a 90 day plan to prepare for potential wars or lockdowns with no imports of food (MSB, 2022)*
    c) Strategies and key projects to reach goals of increased self reliance short and long term (including protection of farmland) and potentials for expansion of farmland/grazing areas as well as education, funding and market places for local regenerative farmers



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### What data I took from it?

Numbers: harvest of walnuts & chestnuts /ha
Theory and inspiration of forest gardening

Numbers: production in a market garden
Numbers of chicken, eggs, meat - incl. feed

Numbers of aquaponics

Numbers: 7 ton grains per ha is normal
Numbers of fruit production per ha

Numbers: Vegetable consumption & production
Numbers: Food consumption (plant foods)

Definition of Food sovereignty.

Numbers of land per animal unit + inspiration

----- || -----

Definition: Regenerative agric + inspiration

Inspiration of "no till" regenerative farming

Numbers of milk per cow/animal unit

Deeper understanding on nutrition science

Estimation on food consumption and production on Orust 2012 and 2022.

### Ocean farming


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Mussel farming harvest per ha, methods, etc.

Numbers: Production 10 tons seaweed/ha

Numbers: Mussels water filtration potential

Numbers: Mussel farming, suitable ratios in feed

Inspiration on future ocean farming

# Thank you for reading!

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Thomas Ivarsson - Orust mat

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at the course on regenerative agriculture.

Chalmers students and teachers.

*If you want to work more with these topics in your context, don't hesitate to contact me!*

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