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Deliverable 2.5: Forward-looking analysis of transition pathways

Sub-report: The land use domain in the Netherlands

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Preface

This report is produced in the context of work package 2 (‘Dynamics of transition pathways’) of the FP-7 funded PATHWAYS project (‘Exploring transition pathways to sustainable, low carbon societies’). This report is a sub-report of deliverable 2.5. (‘Forward-looking analysis of transition pathways’) and describes the socio-technical scenarios for the land use domain in the Netherlands. Deliverable 2.5 (‘Dynamics of transition pathways’) aims to develop an endogenous underpinning of the quantitative patterns (which makes it different from many existing scenarios based on macro-deterministic variables) that are necessary to develop sustainable pathways in the agro-food domain.

The analysis in this report is based on a research guideline that is shared between the different contributors to WP2 to enable comparative analysis of findings between countries (UK, Netherlands, Sweden, Portugal, Germany, and Hungary) and empirical domains (electricity, heat, mobility, agro-food and land-use).
Executive summary
This report develops two socio-technical scenarios for the Dutch land use domain. In this report two endogenous qualitative storylines are developed for the quantitative pathways A and B, which have been developed in Deliverable 1.3 (Figure A and B).

Figure A Schematic representations of the proportions occupied by the different land cover classes used as input of the cSAR model for the Netherlands.

Figure B Relationship between the richness of the different species groups and the different pathways: (a) Total species (b) forest species (c) farmland species (d) and other natural species.

The socio-technical scenarios build on the previous deliverables in Work package 2 (Deliverable 2.1-2.4); the analysis of niches and their momentum and regimes and their lock-ins and cracks and tensions. As an intermediate step so-called ‘transition challenges’ are
articulated. The transition challenge is the tension between the Multilevel analysis of niches and regimes and the future model outcomes (as shown in Deliverable 1.3) (see Table A).

<table>
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<th>Innovation/ regime developments</th>
<th>Pathway A</th>
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<td>Business and Biodiversity</td>
<td>Businesses do only take some measures to reduce their impact as a result of more stringent regulations, but only via sourcing their resources.</td>
<td>Businesses feel the urgency of dealing with biodiversity) issues and scarcity of resources (and are encouraged to do so by policy. Businesses take responsibility in the chain and help other actors in the chain (e.g. farmers) to maintain biodiversity (for example by paying a higher price and demanding extra measures). New business models are needed.</td>
<td>Economy (B), social acceptance (A), Policy (A and B)</td>
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<tr>
<td>Agricultural nature conservation</td>
<td>Agriculture is becoming more intensive and there is not much room for extensive agriculture or nature conservation on arable land. This niche will not develop further in Pathway A.</td>
<td>A mix of land use functions is rewarded and possibilities to safeguard biodiversity on agricultural land are taken.</td>
<td>Social acceptance (A and B)</td>
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<td>Resilient landscapes</td>
<td>Technological measures to prevent flood in areas are taken.</td>
<td>Public safety goals and biodiversity goals are coupled, leading to new solutions.</td>
<td>Economy (B), technological readiness (A and B)</td>
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<td>Renewable energy</td>
<td>Renewable energy is not part of the model scenarios for land use. However, an expansion of renewable energy can be expected. In Pathway A this is believed to be a new type of income for farmers that quit their business.</td>
<td>In Pathway B renewable energy will become part of multifunctional land use. It is an additional source of income for farmers. Furthermore renewable energy is locally arranged by actors in society.</td>
<td>Economy (A and B), societal acceptance (B)</td>
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<td>Urban farming</td>
<td>In Pathway A urban farming is not expected to increase. There will be developed green areas in cities, as cities are growing and more people are going to live in the cities, but that will lead to urban nature and not to urban farming</td>
<td>Urban farming will increase. This is not so much influencing biodiversity or reduction of GHG emissions, but is helping to develop the connection between consumption and production of food.</td>
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<td>Tourism</td>
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<td>Rewilding vs mosaic landscapes</td>
<td>Separation of functions and areas only used for the activity that fits best. Area not suitable for agriculture will become nature: Societal acceptance is important: who decides on which areas are suitable for agriculture and in case this will be realised, we ‘decide’ that small scale farming on high nature value farmlands will no longer exist.</td>
<td>No rewilding, but combinations of functions (‘a bit of nature everywhere’). Combinations of functions: local and regional developments</td>
<td>Social acceptance Policy (A and B) Policy (B), economics (B)</td>
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</table>
Energy, food and wood are produced locally or regionally. Not part of Pathway A. Business models need to be developed to make it attractive to produce locally. Economics (B)

agriculture is interwoven with natural corridors. Not part of Pathway A. Measures are taken everywhere to maintain and protect biodiversity; this leads to lower production (as a result of less intensive farming) and therefore could lead to an increase in import. Social acceptance (B), Policy (B)

Green veining vs connecting areas (corridor). Corridors: connecting large agricultural areas. Green veining. Social acceptance (A and B), Policy (A and B), Economics (A and B)

Multifunctional agriculture. Not in Pathway A: Pathway A is focussed on efficient production. - Way to get NGOs involved - Business models needed. Economics (A and B), Social acceptance (B)

Reduce agricultural land use. In PWA: focussing agriculture production on highly productive areas; other areas are used for nature, living etc. In PW B: combining agriculture with other functions, in order to increase biodiversity all over the place. Compensation of farmers for secondary activities. Social acceptance (A and B), Economics (B)

Table A Tensions between future model scenarios for land use and WP-2 findings of niche-momentum and path dependencies

Below the two scenarios are presented.

Pathway A
This scenario provides a socio-technical storyline for pathway A from D1.3. In the PATHWAYS project this pathway is defined as focussing on large-scale technologies, which represent disruptive technical change, but leaves many elements of the socio-technical system intact. The main actors active in this pathway are the incumbent actors. In land use the main characteristics of Pathway A are:
Large-scale technological optimal solutions (e.g. intensive agriculture and a high level of international coordination e.g. through trade liberalisation)
Rewilding in areas that are less productive
Technology based solutions: Enhanced crop and livestock productivity lead to a decrease in land use: applying technologies focussing on reducing external impacts such as pollution, and the use of biological techniques such as improved varieties and crops, biological control of pests, high productive tree species in plantations.
Intensive agriculture: technology is key. Increasing productivity is necessary to get societal approvement of ‘new type of rural areas’.
Separation of land use functions: areas are used for one type of land cover, as that is most efficient. Agricultural areas are used for (high productive) agriculture and nature areas are used for nature (of high quality).

The major transition challenges concern (based on Table 12):
Social acceptance: This Pathway asks for an emphasis on highly productive areas. That means that social acceptance is necessary for intensive agriculture and that typical types of agriculture in less favourite areas are no longer supported.

Policy: In this pathway the CAP budget will decrease.

Economics: Markets will get liberalized and subsidies will decrease. That asks for other business models to be able to earn an income and pay for maintenance of nature.

There are landscape developments expected that can assist niche-innovations or pressure regimes. In the following decades it is expected that the effects of climate change will become increasingly noticeable. For example for the Netherlands changes in the weather are expected. The temperature will increase leading to less cold winters and warmer summers. The amount of rainfall will increase both in winter and summer time. Hail and thunder will become more extreme, but the speed of the wind will remain more a less the same (KNMI, 2014). This asks for more resilient landscapes that can deal with weather extremes, as people have to be able to deal with more extreme weather (heavy showers or hail).

Furthermore the worldwide population growth, change in diets, an increasingly urbanized society and increasing competition on resources worldwide will demand changes of the current system.

In Pathways A the government will create an incentive to increase productivity and efficiency via more stringent regulations. However, the government support in terms of available budget is decreased and the markets are steering the developments. Spatial planning is however influenced by other developments; for example the developments in renewable energy or mobility.

Technologies and need for more societal acceptance (2015-2030)

Since the renewed Common Agricultural Policy (CAP) that has started in 2015/2016 the first ideas were collected to develop a renewed vision on the CAP after 2020. In Pathway A the choice was made in the CAP to reduce payments for High Nature Value Farmlands. The idea was to focus agricultural production only on the high productive areas. Separation of functions will increase: technologies are making it possible to increase production on agricultural areas, leading to rewilding areas at other spots.

Plans were made to reduce the CAP budget. The farmers in areas that are less suitable-for-agriculture areas were protesting. However, society was no longer accepting that a large part of the EU budget was spent on farmers. For the Netherlands the reduction of the CAP budget for less favourite areas did only lead to a minor decrease of CAP budget as there are only limited areas in the Netherlands making use of this budget. To compensate the farmers, there was still budget available for maintaining nature in the less productive areas. However, that budget was planned to decrease as well.

In 2020 a new strategic plan on biodiversity was developed, using the SDGs for 2030 making the connections between biodiversity and different sectors. In the Strategic Plan for 2030 of the CBD plan traditional nature conservation was put central.

Urgency was growing as risks such as diseases, decrease of soil quality and water quality and food safety are higher on the agenda and policy was urging the larger companies to deal with these issues.
Societal acceptance was important as society had to accept that only the high productive areas are used for farming, and typical local production areas were reduced. However, a reduction of less productive agricultural areas did lead to larger areas with ‘real nature’ and rewilding.

Since 2011 the lion share of the innovation policy was arranged via so called Topsector policy, so was the case for the agro-food sector. Via this instrument innovations are developed in public-private partnerships. The focus in this policy was very much on increasing efficiency and productivity and finding solutions to decrease the emissions.

High technical efficiency is the most important element of this pathway. This efficiency enabled export outside Europe of agricultural goods and services. The demand for renewable raw materials such as rapeseed oil and ethanol rises, due to the rapidly increasing price of fossil fuels and the strong growth in industrial production. Crop yields increase as a result of for example technical progress, improved seeds, better management, mechanisation, pest and disease control (PBL, 2014).

In the 2020s hot debates between long established environmental NGOs, traditional political parties and new but relatively strong political parties related to back to nature movement occurred concerning the design and goals of protected areas. While all agree on a doubling of protected areas, disagreement remains on whether to allow partial use of the areas or complete human exclusion (OpenNess, 2015).

Regime developments

The agricultural regime was strongly locked in. In the agricultural regime the focus was on increasing production. Because the budget of the CAP was declining and the markets were liberalized, farmers were encouraged to increase the production, however, with taking into account the environmental impact.

Higher inputs of capital (mechanisation), fertilizers and other chemicals can have negative impacts on biodiversity (PBL, 2014). Therefore technological solutions need to be found to limit the emissions of farms. These were mainly end-of-pipe solutions, for example closed animal systems with systems that clean the air. Production became increasingly more efficient and as a result of scarcity of fossil fuels and the improved technologies to adapt the amount of artificial fertilizer and pesticides to the specific situation, the amount of fertilizer and pesticides used was reduced. As the amount of subsidies on the agricultural market decreased rapidly, farmers were producing increasingly for the international markets.

As a result of increased urgency to reach the goals for maintaining biodiversity and climate change and reducing further environmental impacts, environmental standards became more stringent, and the fines for not reaching the targets increased. Only the very efficient and highly productive farmers were able to reach the goals.

Besides the highly productive agricultural sector counter-movements started to develop in society. The gap between people living in the city and farmers producing food did became larger, not in the last place as a result of closed farms, and some social movements are demanding companies to open up. Consumerism became the leading life style all over Europe, and the majority of Europeans enjoy the benefits of the flourishing economy. The standards for quality of products did rise, as consumers wanted to have good and safe products in the supermarkets.
Regarding the nature regime, the reduced budgets asked for new ways to finance nature development. At European policy level, rewilding was recognized as a new conservation approach that is able to extend the scope and impact of EU nature policy in a cost-efficient manner, supporting a better implementation of the Nature Directives. One of the steps in this process was to change the status of wild bovids and horses, which were so far only recognized by law as domestic animals, while they are in line with species reintroduction policies. These animals showed to significantly contribute to ecological processes.

The area of nature started to slowly increase in some parts of the Netherlands, especially in the north eastern and eastern part of the Netherlands. As the distinction between nature and agriculture did become clearer, as a result of increased efficiency of agricultural production, the nature organisations in the Netherlands are developing rewilding areas in parts of the Netherlands. Although they were happy with the increasing amount of ‘real nature’ they need to find ways to find budget for maintenance of all these areas.

In the water regime the niche innovation room for the river did find its way into the water regime. This innovation, with many technological solutions was able to connect with the nature regime and thereby creating a good social ground for changes in the river landscape. It took a while, as the water regime was institutionalised locked in, but the niche became successful as it connected different issues simultaneously: flood protection and nature conservation.

Urban areas are growing. Since the 1960s the cities were losing popularity, but recently the population in cities grew faster than in smaller villages. That was mainly due to the increase in immigrants. An increasing amount of people was leaving the city, but they are living close by large cities. However, there was a movement from people from the rural areas (especially in the south, north eastern and southwestern part of the Netherlands) to the western part of the Netherlands. The main causes for the decrease in population in rural areas was that more families with children, young people and higher educated people are moving towards cities. In the less densely populated areas the number of jobs and facilities (like schools and shops) are decreasing. The number of people living in cities was increasing as well, as the number of immigrants in cities was growing. The build up area started to increase. However, the quality of the environment was getting more important as well, as the distance to green areas grew as a result of increasing urban areas. The attention for green areas in the city started to increase around 2025.

The environmental pressure was increasing and norms are becoming more stringent. The government was setting ambitious targets to reduce emissions on the one hand and was stimulating innovations at the other hand. This leads mainly to technological innovations, focusing on end-of-pipe solutions. Many technologies became available, for example using LED lights for growing crops, however society was hesitant. Furthermore the focus was mainly on increasing efficiency and production in the agricultural sector. Growing plants in buildings however, was not really accepted by the public as it was not perceived ‘natural’ by citizens and therefore resistance was growing. Related to this, the discussion on mega farms that started in the early 2000s did become important again. While society was opposing these kinds of developments, the environmental pressure on the agro-food sector was asking for technological solutions to produce in a more efficient way. While companies are improving technologies, society seems to remain behind. Around 2020 it becomes clear that measures should be taken to reach the goals. The government was trying to influence the social acceptance of this type of technologies. The NGOs played an important role in realising this
increased awareness. Geo-political issues had a large impact on the Dutch markets and increased the need to focus production as much as possible in the Netherlands. As an important player in the in- and export of food and agricultural products, the Dutch agri-food sector was suffering from these issues.

Society was afraid for the risks of concentration agricultural production, in a very intensive way, at certain places, as that can lead to increasing pressure by pests and diseases.

Knowledge development in all regimes was focusing on technology to solve issues with biodiversity, land use and emissions. The focus was on increasing agricultural production and technological solutions to deal with more extreme weather and landscape conditions.

**Niche developments**

The niche innovations that started to gain momentum in this period are rewilding and renewable energy. As a result of increased efficiency in agricultural production areas were more and more used for agricultural production or nature, and these functions were separated. In the agricultural regime, policy was focusing on sustainable intensification. Budgets for multifunctional land use were decreasing. Rewilding did take place in the nature areas. In order to pay the maintenance of the area, tourists were attracted by nature conservation organisations.

Another niche that gained momentum was ‘renewable energy’. The increasing demand for food, the increasing efficiency of renewable energy production and the decrease in the amount of land used for growing crops created opportunities for people in the rural areas to develop ideas for renewable energy production. Scarcity of fossil fuels and geopolitical issues did feed this development as well, so the urgency to increase national renewable energy increased rapidly. Furthermore the niche was a solution for farmers that need to look for other types of income and did fit in the landscape as well.

The momentum for the room for the river niche was already medium in 2015. The water regime needed extra policy in order to find nature based solutions to deal with increasing water levels and climate change, so therefore the Room for the river niche did become part of the policy on water in the Netherlands and therefore can be seen as part of the water regime.

Besides these niche innovations, the attention was mainly on technological developments and nature based solutions in agriculture.

**From CAP to innovation policy (2030-2050)**

In 2025 it seems that the Sustainable Development Goals, as agreed upon in 2015, and the Aichi targets were not reached, so the urgency increased something has to be done in order to stop the decrease of biodiversity and reduce the GHG emissions drastically. More ambitious goals are set (1.5 degree target instead of 2 degree) by the European government and via regulation actors in the land use domain are forced to reach these goals. The focus was on technocratic solutions, but there was a risk that technologies will be seen as solutions to limit the impact on the environment, while that was not enough too reach the goals.

The degradation of ecosystems in some European regions pushed technical solutions to their limits and require increasing amounts of money. Increasing environmental problems motivate the transition from fossil fuels to renewables, with a strong focus on technical solutions and less on bio-based options. Simultaneously, the growing demand for provisioning services
such as agricultural commodities and base materials was satisfied by imports from outside Europe, triggering an increase in agricultural areas outside Europe. This development also balances to some extent the huge trade surplus based on the export of industrial products and technologies (OpenNess, 2015).

Around 2030 the decision was made to end the CAP budgets. CAP transforms in a policy to stimulate technological innovation to reduce the impact of agriculture. Furthermore rewilding was increasingly seen as an opportunity for conservation policy to shift gear from protecting and designating to restoration that ‘up-grades’ ecosystems, improves network connectivity and creates new value for people (Jepson & Schepers, 2016).

Nature policy was increasingly decentralized: provincial authorities are allowed to develop their own plans regarding nature policy.

**Regime developments**

As the issues with biodiversity are becoming more prominent the societal acceptance for large scale agricultural production for international markets decreased. NGOs were raising questions on why the soils in the Netherlands are exhausted in order to produce for the world market. The answer of policy was that it is important for the export position of the Netherlands. The Netherlands was still an important exporter in the world agricultural trade, and would like to keep that position. That means that as a kind of opposite of the very productive agriculture, there must be very high quality nature areas in order to still reach the targets for biodiversity and GHG emissions. The market and international trade in agricultural products remains important. The smaller farms have difficulties to survive.

The idea to separate agricultural production and nature started to became more institutionalised. The two functions became physically and instructionally more separated. The growth in productivity in agricultural areas made that other areas could be used for nature (including forest) and rewilding.

**Niche developments**

A niche that has started to develop was urban nature. As a result of the increasing urban areas (a growth of 52%), there was more need for developing green areas in or close to build up areas. There was hardly any area suitable for farming close to cities, and as people do want to have some green areas in their surrounding, nature areas are developed close to cities and green areas in cities are developed as well. Rewilding in urban and peri-urban areas did meet these demands. Degraded industrial, mining and agricultural land close to cities was developed into new nature-based attractions. The rural areas became less populated. As a result of the decreasing subsidies for less favourite areas, many areas unsuited for mechanised and competitive agriculture were experiencing land abandonment and outward migration, particularly among young people. These developments led to a decline in rural culture and the decreasing biodiversity-rich habitats. Subsidy mechanisms were too costly and not suitable on the long run, so rewilding developments were a solution to tackle these problems. Rewilding was able to engage with these types of landscape dynamics in a positive, creative and investment-oriented way (Jepson & Schepers, 2016).

A more productive agricultural sector leads to more rewilding: areas only used for nature. Rewilding was seen as a solution in case of piggybacking; in case it can profit from other functions, like water safety or flood protection. However, in the case of room for the river...
there turned out to be boundaries to ‘impact for biodiversity’. Flood protection was still the main goal and therefore biodiversity could benefit from measures taken as long as the measures focus on flood protection.

**Pathway B**

This scenario provides a socio-technical storyline for pathway B from D1.3. In the PATHWAYS project this pathway is defined as focusing on a wider set of changes across several system dimensions in which new entrants play an increasingly large role. Wider shifts in cultural discourses and social legitimacy emerge, which are supported and support a broader, inclusive governance approach (beyond large firms and technologies), reflecting deeper changes in policy paradigms.

The main elements of Pathway B in the Dutch land use domain are:

- Mosaic landscape, green veining, multi-functional land use
- More conservation of biodiversity on agricultural land and in managed forests.
- Improved agricultural productivity is achieved through ecological intensification methods, using a mixture of techniques including mixed cropping, optimising natural pest control such as Integrated Pest Management
- Focus on local and regional developments
- Ecosystem services are gaining importance

The major transition challenges concern (based on Table 12):

- Social acceptance: Social acceptance is necessary in order to combine different functions in one area. This asks for different types of management
- Policy: In this pathway the CAP budget will decrease, but less fast compared to Pathway A. The CAP will change into Common Agriculture and Food Policy, leading to a systems’ approach.
- Economics: Business models are needed to finance the new combinations of functions in the land use domain.

The landscape developments that are expected to force the developments are the increasing effects of climate change (KNMI, 2014), the worldwide population growth, change in diets, an increasingly urbanized society and increasing competition on resources worldwide (EEA, 2015).

*Changing consumption, perception and move towards ecological intensification (2015-2030)*

The changes in consumption patterns (more animal products) in Europe, the goals set to halt the decrease of biodiversity and the increasing pressure on land made that solutions are searched for by focussing on ecological solutions in multifunctional land use, in which different functions of land use did became combined. The focus was on local solutions and trying to involve society with nature, in order to increase the willingness to pay for nature.

Consumers were slightly getting more aware of the impact of food consumption on the environment as a result of successful campaigns by NGOs. The shift in preferences towards a reduction of consumerism has especially strong effects. Much of agricultural production converted into organic farming or sustainable integrated farming and reduced consumption of animal products and increased productivity of ecological farming lower the pressure on land.
resources. Furthermore, ecosystems approaches were mainstreamed into agricultural, water and forestry policy to ensure sustainable use (OpenNess, 2015).

The meat consumption in the Netherlands continued to decline. However, the effects on production of animal products are not yet visible in the Netherlands, as a large part of the production was exported to other countries in Europe. However, the production was becoming less intensive as a result of more stringent environmental measures from 2020 onwards. At that point it became clear that measures are needed in order to meet the SDGs and new goals were set in the New Strategic Plan on Biodiversity. The SDGs are goal setting, however the way to reach the goals was not chosen yet.

Part of the Dutch system was influenced by European decisions. The CAP had a large reform in 2020. The budget remained more or less the same, but the CAP changed into a Common Agricultural and Food Policy. The focus was on encouraging multifunctional land use and not so much more intensive production methods. In that approach farmers are seen as part of the solution to increase biodiversity and reducing GHG emissions. Farmers got a role to maintain the landscape.

Dutch innovation policy was no longer focussed on technological innovation, but rather on ecological intensification. Ecological intensification aims at designing multifunctional agroecosystems that are sustained by nature, by making use of natural functionalities that ecosystems offer and sustainable in their nature (Tittonell, 2014). This demands a landscape approach and requires collective decision making, which calls for institutional innovations. Furthermore policy stimulates value creation in the chain and tries to involve more actors throughout the value chain. In general the focus of policy has changed from focussing on production towards food and ecosystem services.

Decentralisation of policy regarding nature conservation led to a change of focus. The focus was on local and regional ideas, by making local organisations in charge for nature conservation. Also in the CAP the focus was more on local developments.

Regime developments
The regimes in the land use domain have a strong to moderate lock in, mainly caused by large and long term investments and institutionalised lock-ins. Cracks and tensions are mainly caused by changes in policy on both European level (CAP) and national level (more decentralised policy). Budgets were decreasing what made actors looking for other ways to finance their activities. There was a need for more and better business models to calculate the true prices of products and deal with the decreasing budgets for nature conservation. In this Pathway the social awareness was increasing, leading to new opportunities to finance nature and biodiversity via products.

In the water regime there are hardly any cracks and tensions. Flood protection was arranged in room for the river projects and accordingly coupled with nature conservation.

In the agricultural regime the incumbent actors were trying to change their role in the value chain. That was however hard, as the chain was locked-in as a result of price wars on products. However from 2020 onwards more consumers are willing to pay a higher price for improved quality: direct product quality or quality of the environment. Saturation of markets for food products and the pressure on prices make that farmers are looking for other ways to...
sell their product: for example by giving attention to production methods, quality, or ecosystem services.

An increasing number of experienced and new farmers and cooperatives start to diversify production, at lower levels of land-use intensity and mechanisation. Initial difficulties make imports of agricultural commodities from outside the EU necessary. Europe’s temporary agricultural imports only partly compensate for the huge amount of feed and other products imported before the crisis, causing a net reduction in trade and revenues outside Europe (OpenNess, 2015).

The nature regime was looking for new ways to finance nature as budgets were declining. It was however hard to find new ways to gain budgets.

Niche innovations
The more extensive production methods, like organic farming are also induced by new policy that aimed to make it easier to change from a conventional production towards organic farming. While in the 2000s this was a huge and expensive hurdle to take for farmers, from 2017 onwards it became more attractive to make that step. Agricultural nature conservation was growing in importance. Combining agriculture and nature was seen as one of the solutions to maintain and improve biodiversity.

Large companies like Heineken were starting to get more aware of their impact on the environment and the niche business and biodiversity became larger. This was partly because of the increasing scarcity of resources, but also NGOs confronted companies with their responsibilities to maintain nature and biodiversity. New business models were developed that calculate the price of products with taking into account the impact on the environment. True pricing was getting more prominent and once a couple of large players in the food business are using ‘true prices’ others follow soon. NGOs have an important role by naming and shaming the ones lagging behind.

Nature became perceived as solution from a market orientation. This was encouraged via policy, the market and consumer choices. However, new business models are not there yet and needed to be developed.

The gap between consumers and the production of food was very large. As a result of the increasing amount of diseases related to farming and problems with resistant bacteria, consumers became more willing to know where and how their food is produced. This was an opportunity for local farmers to profit from. The slightly higher price for products is used in the area the production took place. Another related niche that was increasing in momentum was urban agriculture. Although this trend did not have a large impact in terms of biodiversity conservation or lowering emissions, it did play a role in social cohesion and redeveloping the connection between food production and consumption. Furthermore it made people more aware of the environment they live in and thereby increased the attention for green areas and nature. In cities more green areas are developed and people are enjoying nature.

Renewable energy was getting more important. Geopolitical issues with some of the most important oil countries made that the Netherlands wanted to become less dependent on fossil fuels. The subsidies for renewable energy increased, although there was still a lack of social acceptance. NIMBY (Not In My Backyard) was an important problem: people were not
willing to have large wind turbines in their surroundings. However on the other hand local initiatives popped up in which people together organised renewable energy in their village or city. In so-called energy co-operations they collected funding for wind turbines or solar panels, which are used on the roofs of municipality buildings. This also fits the developments towards a more locally organised community that was trying to become less dependent on global resources. Furthermore wind turbines are a good alternative source of income for farmers: as agricultural production was no longer becoming more intensive and the amount of payments was reduced, renewable energy was a very welcome source of income. Another way for farmers to get a higher income was tourism. This kind of secondary activities was gaining popularity. A growing demand for ecosystem services, related to tourism and recreation, started to develop. Simultaneously, an alliance between agrarian and industrial lobbies additionally weakens policies protecting the environment and preserving nature (OpenNess, 2015)

Tourism was also in another way effecting land use practices. Developing and especially maintaining nature needs to be paid. The number of members of nature organisations was declining, so other ways to get a budget needed to be found. By asking an entrance fee, parts of the costs are covered. However, that seemed not to be the solution, as people are not willing to pay fee for every time they spend their leisure time in nature. However, a side effect of tourism was that human activities can have negative effects on nature and biodiversity through disturbance of the remaining natural and semi-natural areas. Fragmentation, for example by roads, does lead to a decrease in number of species that require large areas (PBL, 2014). Solutions to prevent this kind of effects needed to be found in the next years.

NGOs are playing a more important role in connecting different functions of areas. Stichting Ark (Association involved in Room for the River) was an example of an organisation that was able to connect public safety and nature conservation in projects focussing on water.

**Multifunctional land use (2030-2050)**

Most of the environmental movements and NGOs supported national governments and the EU administration in their efforts to develop and adapt environmental legislation. However, the unsuccessful trials of participatory policy design at the EU level, due to immense administration and considerable limits in feasibility. While the EU continues to be a strong actor, its role changes towards an institution which facilitates regional approaches and pan-European knowledge exchange (OpenNess, 2015).

The reform of the CAP did lead to more multifunctional land use. However it seemed that the goals regarding biodiversity are not easily met. Therefore more stringent measures are taken that force actors to reduce the impact on land and biodiversity.

After the European economy and many EU institutions dwindled in the late 2020s and early 2030s, Europe has been losing power and many of its leading roles in politics and the economy. However, many branches of the back to nature movement have been wise enough to coordinate the countless applications and research in re-establishing and promoting numerous of the well adapted varieties of almost forgotten crop types, vegetables, fruits, old livestock races and sustainable management strategies on regional and national levels. Some of the larger cooperatives gain importance in Europe and beyond in production and distribution of robust seeds, livestock, but also technologies adapted to sustainable production. While successful regional organisations / cooperatives are increasingly trading
with similar cooperative organisations, which are gaining popularity in other parts of the world, some of the less organised regions seem to be left behind. In contrast, many of the large multi-national companies and agro-industries move out of Europe, while several others adapt strategies, technologies and company structures to better match new demands and markets. After the recovery of the restructured economy, inner-European and international trade slowly increases to moderate levels (OpenNess, 2015).

Regime developments
The SDGs became more important, as the goals were not reached yet in 2025. Therefore Europe decides to set more stringent targets: the 2 degree target became a 1.5 degree target. That urged actors to take action. More stringent environmental measures were taken and goals were set on biodiversity as well.

Urban areas were increasing, but less fast compared to Pathway A. The amount of semi-natural areas increased by 5%, while forests decrease with 6%. These changes were the result of an increase in multifunctional land use.

Policy was mainly focussing on combinations of land use.

Niche innovations
Farmers were framed as caretakers for the landscape, plants and animals got an important function in the landscape in relation to biodiversity. The biodiversity on agricultural land increased and both large food producers and consumers became willing to reward the extra measures taken to increase biodiversity by producing food. The main challenge of multifunctional land use was that new business models were needed to reward ecosystem services. Collaborations between big food companies and retailers helped farmers to increase biodiversity on their land and the external costs became part of food prices. That made it possible that businesses are paying for nature conservation and ideas like business and biodiversity are getting more important.

NGOs also played an import role in increasing consumer awareness regarding environmental issues related to consumption. A larger group of consumers became willing to pay higher prices for quality, food safety and taste. These higher prices can be used for decreasing the environmental impact and taking measures to prevent biodiversity loss as result of production.

Urban farming became more popular, but also had its backside effects. Production in urban farming was limited and due to increasing environmental impacts of for example fine dust in cities there are risks related to food that has been produced in cities. However, the amount of green areas in cities increased as a result of people wanted to have green surroundings.

A combination of functions was rewarded by policy. Solutions to decrease emissions are found in nature based solutions; however it was hard to reach the goals in that way.

The size of the area used for agriculture increased and productivity will increase as well in order to be able to feed the world.
Concluding comments
It is hard to realize a transition in the land use domain, because of sunken costs, allocation of land use and the influence of natural elements like climate change on land use. Furthermore land use is influenced not only by policy on land use, but also by developments in other domains, like mobility, energy and agro-food. As the transition challenges described showed, both pathways require substantial reorientations of current trajectories. However, changes are occurring very slowly, partly due to the nature of the land use domain and partly because changes in for example regulations are very hard to organize. The challenges are mainly in economics (how to pay for nature development), policy (decisions taken on different levels) and social acceptance (for example whether or not using EU budget for farmers, maintaining particular local production). However transitions can be made if relevant actors change their commitments, strategies, investments, and behaviours.

Similarities and differences in transition pathways
In the table below (Table B) some of the main elements of both pathways are described and compared.

<table>
<thead>
<tr>
<th>Elements of Pathways</th>
<th>PW A</th>
<th>PW B</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAP</td>
<td>Decrease in budget</td>
<td>Budget remains more or less the same</td>
</tr>
<tr>
<td>Knowledge and innovation</td>
<td>Improve current developments: more efficiency</td>
<td>Broader knowledge base; more attention for business models</td>
</tr>
<tr>
<td>Technology</td>
<td>Hard technological solutions</td>
<td>Nature based solutions</td>
</tr>
<tr>
<td>Consumers</td>
<td>more stringent standards for products</td>
<td>extra attention for what is more than the standard</td>
</tr>
<tr>
<td>Chains</td>
<td>Global chains</td>
<td>Regional and local chains</td>
</tr>
<tr>
<td>Environmental policy</td>
<td>Stringent environmental policy and steering on innovation</td>
<td>Stringent environmental policy and steering on behaviour</td>
</tr>
<tr>
<td>Spatial planning</td>
<td>Separation of functions, land abandonment</td>
<td>Multifunctional land use, fit in the landscape is more important</td>
</tr>
<tr>
<td>Markets</td>
<td>Global dynamics</td>
<td>Regional markets, decentralised societal debate</td>
</tr>
<tr>
<td>Sustainability approach</td>
<td>Sustainable intensification</td>
<td>Ecological intensification</td>
</tr>
</tbody>
</table>

Table B  Similarities and differences in transition pathways
The main similarities and differences between the two pathways A and B are:
- The amount of built-up area will increase, although the size of the increase differs.
- Pathway B is focussing nature based solutions, while pathway A is focussing on limiting the risks and prevents the largest impact by technological solutions.
- In Pathway A the budget of the CAP will increase, while in Pathway B the budget will remain more or less the same.

Policy risks
Countries need to take their responsibilities and do commitments in order to reach these targets. Decisions had to be taken on how to reach the goals. For example the SDGs are goal-setting, but the way how to reach the goals is not clear.

One of the risks is that social acceptance is hard to mobilise. It does take some time after measures are taken that biodiversity is increasing (as it takes time for example for trees to grow and reproduce). Therefore it is difficult as well to get actors motivated to take action, as the result is on only visible on the long run. The same counts for farmers: it is harder to take
measures that are costly, when the effect of the measures on for example soil quality will only be visible in a couple of years.

A second risk is that technology development to increase efficiency develops slower than anticipated and does not contribute as much as is anticipated. Especially the Netherlands is already a very productive country in terms of agricultural production, so the question is how much growth is possible.

In order to make something happen in the locked in land use regimes, very stringent governmental measures are needed. Changes in land use occur slowly and therefore effects will only be visible in long term.

In Pathway B the routes to reach the goals are limited and it is even the question whether goals will be reached. The niche innovations in Pathway B have hard times to increase momentum, as overall the Dutch policy on land use has a Pathway A focus. Only if it possible to connect with other goals, like in the case of room for the river, it will be possible to develop multifunctional land use as a solution to reach the targets.

**Wider policy implications**
Based on the scenarios we can draw broader policy implications. The urgency to speed up ongoing developments and strengthen commitments is high. Both scenarios require major reorientations and decisions on that reorientation need to be taken soon, in the coming decade.

Both scenarios ask action from policymakers. In both scenarios more stringent measures on reaching the emission targets and biodiversity goals are needed. In Pathway A these measures will be combined with innovation policy encouraging technological innovations to reduce emissions, while in Pathway B the focus of policy needs to be on bringing partners in the chains together in order to take responsibility regarding improvements and combine different goals and functions.

Social acceptance is the third point that needs attention. Whatever decision is made, social and cultural dimensions need to be taken into account in order to make them work out. Land is visible everywhere and people do have an opinion about it. Liveability of the area people live in is important as well, and therefore society should be taken along in decision making.
1. Introduction

Goal and questions
Intensity with which land is used contributes to changes in species composition and biodiversity loss (MacDonald et al., 2000). At the global scale, population is expected to increase from around 7 billion in 2010 to 9.2 billion by 2050, increasing GDP by fourfold, food consumption by 1.7 times and wood consumption by 1.3 times (Vuuren van & Kok, 2012). A lot of these developments will increase the pressure on land use and change in land cover, leading to habitat loss and biodiversity loss. For instance, agricultural land (croplands and pastures) is projected to expand by 10% and total forest area to decrease (Vuuren van & Kok, 2012). Land use change is often considered to be a primary driver for biodiversity and ecosystems changes.

In order to have an idea of what will happen in the future in the land use domain and how to deal with these changes, this report (D 2.5) aims to develop qualitative storylines that describe plausible socio-technical transition pathways for the revised quantitative scenarios that have been developed in WP1 in the context of D1.3. The revised WP1 scenarios are that starting point and taken for granted in this report. Based on the revised scenarios this document focusses on what will need to change (in a socio-technical sense) in order to make those quantitative scenarios happen. This report describes a forward-oriented analysis, which builds on the previous deliverables that investigated historical trajectories of the least decade: D2.1 analysed green niche-innovations and their momentum.
D2.2 analyses stability and tensions of incumbent socio-technical regimes.
D2.3 integrated findings from D2.1 and D2.2 to make it possible to assess feasibility of different transition pathways.
D2.4 made a comparative country analysis of contemporary transition pathways in different domains.
D2.5 makes the step from the recent past towards future transition pathways. To develop future transition pathways from a socio-technical perspective, D2.5 uses a relatively new methodology: socio-technical scenarios.

The central questions in this report are:
1. In what way will Pathway A and pathway B have to develop to reach the goals as defined in Workpackage 1?
   o We assume that a 49% reduction in non-CO2 GHG emissions is necessary by the year 2050 compared to the year 1990. As non-CO2 GHG emissions already decreased by around 15% over the period 1990-2005, still a 30% reduction in GHG is needed between 2005 and 2050.
   o Agricultural land use is reduced by 15% (both for arable land as well as for grasslands) (in order to halt biodiversity loss).
   o It is assumed that the objective is that the net import balance (in hectares) for the commodities soy beans, palm oil and cereals is reduced by 30% in 2050 compared to 2010.
2. What will be the core branching points/decisions/policies?
3. What are the policy implications/robust advices that can help to get to a more sustainable, low carbon society?

Background of this report
This report describes the socio-technical scenarios for the two pathways (A and B) in the land use domain. Scenarios are developed based on existing knowledge of experts in the team,
however ideally we would have done this exercise together with stakeholders. There are however some issues that need to be dealt with.

First, the MLP analysis that is central in WP2 is done on country level, while model results (WP1) are (mainly) on European level. That means we needed to upscale results from the MLP analysis at country level to the European level and the other way around.

Second, there are no goal-oriented IAMs available in the land use and biodiversity domain. That means that the models are not focusing on reaching the goals in the first place. However, in order to be able to make a scenario that is reaching the goals, it is necessary to do some assumptions on goals.

Third, a lot of the policy regarding land use and biodiversity is developed on European level (Common Agricultural Policy), within objectives set at the Global level (Convention Biodiversity and its translation into the European Biodiversity Strategy). So, national policies are designed within the limits of European policy.

Because of the characteristics of the land use domain (land based, very heterogeneous, multiple policy domains) and the nature of the innovations (a strong social and organisational component), it can be expected that changes in the land use domain follow a different pathway than the technological innovations such as the electricity system (Verbong & Geels, 2007) or the steam ship (Geels, 2002). Therefore we prefer in the land use domain to talk about a socio-ecological system, as ecological systems and technologies are both important in the land use domain.

Transitions in land use systems are likely to be characterised by diversity and to result from push-and-pull efforts by niche actors in cooperation with regime actors (of the agricultural or other regimes). The regimes in the land use domain are neither homogenous nor monolithic as there is a close link between for example farming and its (natural and social) context, its spatial dependence, the diverse functions it fulfils, and the diverse societal expectations it faces. Furthermore many transitions in the land use domain typically involve not only technology but include new organizational forms and practices, using for example nature based solutions in river management or ecological solutions in agriculture.

Darnhofer et al (2014) defined the features that distinguish the agricultural sector from the industrial and service sector while studying transitions, that are relevant for the land use domain as well. The following features contribute to the high level of policy involvement in the sector.

- Diversity in farming: Farming is a land based activity what makes it shaped by the local agri-ecosystem, topography and climate, and the traditions, economic structures and social norms that co-evolved in this natural environment. Even within regions there is diversity in farm size, activity and market orientation. Diversity in farming is therefore high what makes that transitions are not likely to lead to a uniform set of practices, but rather a mix of different practices and different linkages between elements of the farming system. This diversity makes it difficult to pinpoint a clear transition from practices ‘X’ to ‘Y’.

- Spatial nature: Both bio-physical conditions and the location of the region (peripheral or close to urban areas) play a role in the types of transitions that are more likely to take-off (Marsden, 2013).

- Multi-functionality: Farming is often perceived as having primarily one societal function: food production. In MLP terms the agro sector is a socio-technical regime, with constituting sub-regimes such as agricultural policy, agricultural research, the
agro-food industry and market and consumer preferences. However since the 1990s the multi-functionality of the sector is coming to the fore; the agricultural sector is not only producing food and other goods (e.g. fibres or energy), but is also providing other (non-market) functions such as protection of natural resources, maintenance of forests, biotopes and other valued elements of landscapes and contributes to the cultural heritage of rural areas.

- Public good character: Farms contribute to several crucial functions in society, farmers are stewards of over half of Europe’s territory and farmers are producing many public goods. This led to a high level of policy involvement.

Structure of report
Chapter 2 gives an overview of the quantitative scenarios from Work package 1 (D.1). Chapter 3 is an overview of the current socio-technical trends (2000-2015). Chapter 4 articulates the transition challenges by comparing outcomes from chapter 2 and 3. Chapter 5 and 6 explain the Pathway A and B socio-technical scenarios. Concluding remarks are presented in chapter 7.
2. Quantitative scenarios from WP1

The way in which the land is used, its intensity and extent, can impact biodiversity differently. From WP1 we learned that, globally and in a business as usual scenario (Pathway 0), the total agricultural area is expected to increase, although much less than production, due to expected increases in productivity: while production is expected to increase by more than 50% between 2010 and 2050, agricultural land use will only increase by about 10%. At the same time, the downward trend in nature area is expected to continue (van Sluisveld et al., 2014). In Pathway A there is a projected intensification of agriculture to combat degradation and biodiversity loss; whereas in Pathway B the focus is on extensive agriculture and increase of multifunctional land use. The main ideas behind the pathways are presented in the table below (Table 1).

In this section we describe the land use change and biodiversity modelling assumptions for each pathway (see 2.1), then we detail the methods used to project these future changes in land use in the Netherlands (section 2.2), and subsequently, their impact on local and regional biodiversity (section 2.3).

<table>
<thead>
<tr>
<th>Pathway 0: Business as Usual</th>
<th>Pathway A: Technical component substitution</th>
<th>Pathway B: Broader regime transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Departure from existing system performance</td>
<td>Minor (no transition)</td>
<td>Substantial</td>
</tr>
<tr>
<td>Lead actors</td>
<td>Incumbent actors (often established industry and policy actors)</td>
<td>Incumbent actors (often established industry and policy actors)</td>
</tr>
<tr>
<td>Depth of change</td>
<td>Incremental change</td>
<td>Radical technical change (substitution), but leaving other system elements mostly intact</td>
</tr>
<tr>
<td>Scope of change</td>
<td>Dynamic stability across multiple dimensions</td>
<td>1-2 dimensions: technical component and/or market change, with socio-cultural and consumer practices unchanged</td>
</tr>
</tbody>
</table>

Table 1: Ideal-type transition pathways and their defining elements

2.1. Model assumptions

Regarding the land use domain, and for the business as usual scenario (or Pathway 0), at the European scale an increase in forest is expected, resulting from the forest transition in which most countries already entered by the end of the 19th century (Meyfroidt and Lambin, 2011). This forest transition is also accompanied by farmland abandonment, particularly in remote areas and on less productive soils (Navarro and Pereira, 2012; Verburg and Overmars, 2009). As a result, natural succession will occur. Consequently, an increase of natural areas other than forest, is expected at least, in the years following farmland abandonment. For the ‘Business as Usual scenario’ several land-use trajectories have been observed in the recent past, which are expected to continue in a “Business as Usual scenario” (BaU or Pathway 0).
Table 2 Summary table of the expected trends for the land-use and biodiversity domains in the Netherlands. (Agr. Sp – agricultural species, For – Forest, On – Other natural).

<table>
<thead>
<tr>
<th>Land-use</th>
<th>Biodiversity (mean richness)</th>
<th>Land-use</th>
<th>Biodiversity (mean richness)</th>
<th>Land-use</th>
<th>Biodiversity (mean richness)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest For. Sp. ↓</td>
<td>Forest For.Sp ↑</td>
<td>Forest For.Sp →</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Regarding Pathway A, sustainability is attained via technological improvement. Better yields and the development of precision farming allow for the intensification of agriculture in productive areas, which leads to the abandonment of less productive and marginal farmland. These trends are expected to be stronger than in the BaU scenario. Natural areas are thus expected to increase due to natural succession on the abandoned lands, leading to an increase in forested areas in the later decades. In this scenario, multifunctional landscapes are projected to decrease in extent. Both intensive agriculture and forest are “locked” in this scenario and remain constant. The rate of loss of extensive agriculture is doubled when compared with the BaU scenario, resulting in larger areas being converted to forest and other natural. The rate of natural succession on Other Natural is supposed to be lower than with the BaU scenario due to management practices that maintain early successional habitats (including rewilding).

Concerning Pathway B, sustainability will be achieved via societal changes such as behavior and consumption patterns changes, which will lead to an increase in multifunctional landscapes. Overall, intensive agricultural areas are predicted to considerably decrease, being converted to extensive agricultural areas (intra-regime transition). This pathway leads to less farmland abandonment (i.e. less new available land for natural succession). As a result, the forest increase is more moderate than in Pathway A.

Following the assumptions on the land use, the biodiversity is expected to decrease in intensive land-use areas (i.e. loss of multifunctionality), due to the homogenization of the agricultural landscape, which will reduce the number of niches available (Guilherme and Pereira, 2013; Navarro et al., 2015; Proença and Pereira, 2013). This type of transitions typically leads to a decrease in the mean richness of farmland species (Table 2) although some species can increase in abundance if they have a high affinity for the resulting homogeneous landscape (Proença and Pereira, 2013). An increase in the area covered by forest, combined with a reduction in direct human pressure (e.g. persecution of large predators) typically leads to an increase in the richness of forest species. This is for instance the case for megafauna which can be favored by an increased availability of habitat and connectivity (Ceausu et al., 2015).
2.2. **Quantitative scenarios for the Dutch land use domain**

2.2.1. **Modeling framework**

Land use impact on biodiversity is not only depended on the amount of land used, but also on the type of land use. Therefore, in order to project biodiversity changes as a result of the different pathways, first we projected future changes in land use until 2050. To do so, we combined the CORINE Land Cover Map of 2012 (100m) with national statistics on forest and agricultural areas and the pathways storylines.

In detail, to create the baseline land use map of 2010, we reclassified Corine’s legend into: intensive agriculture, extensive agriculture, forest, and other natural (Table 3).

<table>
<thead>
<tr>
<th>CLC_CODE</th>
<th>LABEL</th>
<th>Reclassified</th>
<th>Area 1990</th>
<th>Area 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>112</td>
<td>Discontinuous urban fabric</td>
<td>Urban</td>
<td>253792</td>
<td>332347</td>
</tr>
<tr>
<td>121</td>
<td>Industrial or commercial units</td>
<td>Urban</td>
<td>38217</td>
<td>81660</td>
</tr>
<tr>
<td>122</td>
<td>Road and rail networks and associated land</td>
<td>Urban</td>
<td>5079</td>
<td>9654</td>
</tr>
<tr>
<td>123</td>
<td>Port areas</td>
<td>Urban</td>
<td>10120</td>
<td>13723</td>
</tr>
<tr>
<td>124</td>
<td>Airports</td>
<td>Urban</td>
<td>6197</td>
<td>6903</td>
</tr>
<tr>
<td>131</td>
<td>Mineral extraction sites</td>
<td>Urban</td>
<td>1285</td>
<td>4636</td>
</tr>
<tr>
<td>132</td>
<td>Dump sites</td>
<td>Urban</td>
<td>321</td>
<td>2149</td>
</tr>
<tr>
<td>133</td>
<td>Construction sites</td>
<td>Urban</td>
<td>13531</td>
<td>14221</td>
</tr>
<tr>
<td>141</td>
<td>Green urban areas</td>
<td>Urban</td>
<td>10135</td>
<td>14659</td>
</tr>
<tr>
<td>142</td>
<td>Sport and leisure facilities</td>
<td>Urban</td>
<td>30583</td>
<td>51545</td>
</tr>
<tr>
<td>211</td>
<td>Non-irrigated arable land</td>
<td>Intensive Agriculture</td>
<td>790379</td>
<td>738615</td>
</tr>
<tr>
<td>222</td>
<td>Fruit trees and berry plantations</td>
<td>Intensive Agriculture</td>
<td>7262</td>
<td>7162</td>
</tr>
<tr>
<td>231</td>
<td>Pastures</td>
<td>Intensive Agriculture</td>
<td>1138014</td>
<td>1013079</td>
</tr>
<tr>
<td>242</td>
<td>Complex cultivation patterns</td>
<td>Intensive Agriculture</td>
<td>570796</td>
<td>532703</td>
</tr>
<tr>
<td>243</td>
<td>Land principally occupied by agriculture, with natural vegetation</td>
<td>Extensive Agriculture</td>
<td>108856</td>
<td>116660</td>
</tr>
<tr>
<td>311</td>
<td>Broad-leaved forest</td>
<td>Forest</td>
<td>49922</td>
<td>60773</td>
</tr>
<tr>
<td>312</td>
<td>Coniferous forest</td>
<td>Forest</td>
<td>162232</td>
<td>159049</td>
</tr>
<tr>
<td>313</td>
<td>Mixed forest</td>
<td>Forest</td>
<td>93580</td>
<td>94455</td>
</tr>
<tr>
<td>321</td>
<td>Natural grasslands</td>
<td>Other Natural</td>
<td>25963</td>
<td>47827</td>
</tr>
<tr>
<td>322</td>
<td>Moors and heathland</td>
<td>Other Natural</td>
<td>37530</td>
<td>42215</td>
</tr>
<tr>
<td>324</td>
<td>Transitional woodland-shrub</td>
<td>Other Natural</td>
<td>575</td>
<td>1416</td>
</tr>
<tr>
<td>411</td>
<td>Inland marshes</td>
<td>Other Natural</td>
<td>29627</td>
<td>36456</td>
</tr>
<tr>
<td>412</td>
<td>Peat bogs</td>
<td>Other Natural</td>
<td>7613</td>
<td>8076</td>
</tr>
<tr>
<td>421</td>
<td>Salt marshes</td>
<td>Other Natural</td>
<td>9041</td>
<td>9452</td>
</tr>
</tbody>
</table>

*Table 3 Suggested reclassification of the Corine Land Cover classes for the Netherlands into the classes used for the analysis.*

Afterwards, using historical national statistics (CBS, 2016), we determined the business as usual trends, which were then used to produce the land use map of 2050 (Figure 3). These same trends were projected until 2050 assuming the transitions seen in Table 4.
Table 4 Expected transition matrix for the land-uses within the Netherlands following a business as usual scenario between 2010 and 2050 (* Data based on 2010: Area natural grassland is counted as extensive agriculture)

The trends projected for the period 2010-2050 in pathways A and B were obtained by modifying the historical trends (1990-2010) in order to fit the storylines described in section 2.2 and accounting for the expectations of WP1.

The assumptions behind Pathway A are the following:
- The amount of agricultural area will decrease as a result of increasing efficiency in agricultural production.
- Extensive agriculture will decrease as a result of only using the high productive areas. For example, the grasslands that are not so productive are taken out of use.
- The area of nature will increase (but not fast) in area only used for nature as area no longer used for agriculture will become nature), however what the effect is on biodiversity is not clear (as the functions nature and agricultural production were often combined)
- Urban area will increase (more or less as much as in BaU)

For Pathway B the main assumptions are:
- Intensive agricultural land is decreasing and extensive agricultural land is increasing as agricultural production is combined with nature conservation.
- The amount of nature will increase, but not very fast. It is mixed with other land types.
- Urban area will increase a bit less than in BaU, as more people will remain living in the countryside.

In particular, for pathway A, the emphasis is on intensive agriculture. Most agricultural land in the Netherlands will be used and extensive agriculture will no longer exist. Furthermore, a minor expansion of forest is expected and a minor increase of nature areas, as the amount of space only used for nature is increasing. The urban area faces the strongest expansion as more space is needed for shopping, recreation, etc. Regarding water, more technological solutions are needed, so there is a need for expansion (see Table 5).

Table 5 Expected transition matrix for the land-uses within the Netherlands following Pathway A between 2010 and 2050 (* Data based on 2010: Area natural grassland is counted as extensive agriculture)
Regarding pathway B, and following the storyline described in section 2.2, we assumed a strong contraction of intensive agriculture, partially to give room to more extensive agriculture. The amount of forest is stable, as less emphasis is on ‘pure’ nature areas. For the same reason there is only a minor expansion of nature areas. Urban areas will be smaller, but there will be greening in cities as well. Water gets a bit more space, because of the ways to deal with climate change (see Table 6).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>53,40</td>
<td>-3.5%*</td>
<td>Int. Agr.</td>
<td>X 35%</td>
<td>5%</td>
<td>50%</td>
<td>10%</td>
<td>37.7</td>
<td>-29%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,10</td>
<td>67%*</td>
<td>Ext. Agr.</td>
<td>X</td>
<td>8</td>
<td>627%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.30</td>
<td>1,70%</td>
<td>Forest</td>
<td>X</td>
<td>8,3</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,50</td>
<td>9.50%</td>
<td>Oth. Nat.</td>
<td>X</td>
<td>4</td>
<td>14%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15,10</td>
<td>10%</td>
<td>Urb.</td>
<td>X</td>
<td>22</td>
<td>46%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.90</td>
<td>1.50%</td>
<td>Water</td>
<td>X</td>
<td>20</td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6 Expected transition matrix for the land-uses within the Netherlands following Pathway B between 2010 and 2050 (* Data based on 2010: Area natural grassland is counted as extensive agriculture)

To spatially allocate the projected changes in land cover, we assumed that transitions to a new land cover (e.g. extensive agriculture at the expense of intensive agriculture) would be more likely to occur closer to the existing area of that land cover (extensive agriculture areas), thus expanding existing patches, rather than creating new ones.

2.2.2. The scenarios of land use

In the baseline, i.e. 2012, the Dutch territory was distributed as 53.4% intensive agriculture, 1.1% extensive agriculture, 8.3% forest, 3.5% other natural, 15.1% urban areas and 18.9% water. By 2050, and in the business as usual scenario (or Pathway 0), we projected that 46% intensive agriculture, 3.6% extensive agriculture, 3.7% forest, 5% other natural, 21.7% urban areas and 20% water. These changes in land use proportions are a result of projecting the same trends of the last 20 years, as explained in the previous section (Figure 2).
By 2050, in Pathway A, the area of the Netherlands would be 43% intensive agriculture, 0% extensive agriculture, 9% forest, 5% other natural, 23% urban areas and 20% water. In pathway B, on the other hand, the Netherlands would have 37.7% intensive agriculture, 8% extensive agriculture, 8.3% forest, 4% other natural, 22% urban areas and 20% water by 2050 (Figure 2).

The projected land use for 2050 in Pathways A and B differ as a result of the assumptions described in the previous section. Given the focus on technological improvements and the ‘land sparing’ vision of pathway A we projected a complete removal of extensive agriculture in this pathway. Comparatively, in Pathway B, there is a significant decrease in the intensive use of the agricultural land, resulting in an increase in multifunctional areas (extensive agriculture), representing the ‘land sharing’ vision of this pathway (Figure 2).
Figure 2 Land use maps for the Netherlands (a) 2012; b) BaU 2050; c) Pathway A 2050; d) Pathway B 2050.
2.3. **Quantitative scenarios for the biodiversity domain**

2.3.1. **Modeling framework**

The response of biodiversity to land-use change resulting from the three pathways was assessed using the countryside species-area relationship (cSAR) (Pereira and Daily, 2006; Guilherme and Pereira, 2013; Proença and Pereira, 2013; Martins et al. 2014). The countryside SAR builds on the classic SAR ($S=ca^z$) and its application requires two steps. First the countryside SAR estimates the species richness of groups composed by species with similar habitat preferences (Eq. 1), where $S_i$ is the number of species in group $i$, $h_{ij}$ is the affinity of species group $i$ to habitat $j$ and $A_j$ is the area cover by habitat $j$:

$$S_i = c_i(\sum h_{ij}A_j)^z$$  \hspace{1cm} (1)

The parameters $c$ and $z$ are constants that depend on the taxonomic group and sampling scheme respectively, and will be species group dependent. The total number of species in the landscape, $S$, is given by the sum of species in each group (Eq. 2), with $m$ the number of species groups:

$$S = \sum_{i=1}^{m} S_i$$ \hspace{1cm} (2)

We model the species richness $S_{i,t,p}$ of species group $i$ for each pathway $p$ and each time step $t$ (i.e., 2010 and 2050), considering all habitats $j$, as follows:

$$S_{i,t,p} = c_i(\sum h_{ij}A_{tpj})^z$$ \hspace{1cm} (3)

Model parameters (i.e., $c, z$ and habitat affinities ($h_{ij}$)) were derived from Martins et al. (2014), where they assessed the differential use of natural and human-modified habitats by different bird species groups in Portugal. For the intensive land-use classes we assumed that species affinities will decrease by half (Table 7).

<table>
<thead>
<tr>
<th></th>
<th>$c$</th>
<th>$z$</th>
<th>$h_{Aext}$</th>
<th>$h_{Aint}$</th>
<th>$h_{ON}$</th>
<th>$h_{Fext}$</th>
<th>$h_{Fin}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural species</td>
<td>1.84</td>
<td>0.101</td>
<td>1</td>
<td>0.5</td>
<td>0.604</td>
<td>0.305</td>
<td>0.153</td>
</tr>
<tr>
<td>Other natural species</td>
<td>0.67</td>
<td>0.162</td>
<td>0.200</td>
<td>0.100</td>
<td>1</td>
<td>0.362</td>
<td>0.181</td>
</tr>
<tr>
<td>Forest species</td>
<td>1.86</td>
<td>0.126</td>
<td>5.91E-05</td>
<td>2.96E-05</td>
<td>0.007</td>
<td>1</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Table 7 Parameters $h_{Aext}, h_{Aint}, h_{ON}, h_{Fext}$ and $h_{Fin}$, represent the affinity of the species groups for extensive agriculture land, intensive agriculture land, other natural land, extensive forest and intensive forest respectively. $c$ and $z$ are model parameters.

We estimate local species richness (i.e., 10 km x 10 km UTM cells) and regional species richness in the landscape (i.e., country level), and assessed the differences in species richness between the baseline and the projected pathways.

2.3.2. **The Scenarios**

In the Netherlands, we projected that the total levels of biodiversity will increase in all scenarios of land use change (Figure 4 and Figure 5).
Figure 3 Difference between the richness of the different species groups in the pathways and the baseline: (a) Total species (b) forest species (c) farmland species (d) and other natural species.

The mean difference in species richness between Pathway A and Pathway B is -0.23 and the mean difference in local species richness between Pathway A and B is -0.16.

In the BaU scenario by 2050 there is a significant loss in biodiversity compared to the baseline, i.e. 2012 (-4%). On the contrary, in both pathways, by 2050, the total levels of biodiversity increase relative to the baseline (0.4% and 0.7%, in Pathway A and B, respectively). Pathway B leads to higher local species richness than Pathway A, delta=-0.16 (Figure 6). Forest species richness increase more with the technological based scenario (Pathway A), while other natural species increase more with a multifunctionality scenario (Pathway B). Farmland species decrease in all scenarios, and in Pathway A will actually decrease below the values predicted in the BaU scenario (Table 8). Multifunctionality will benefit other natural species over other species groups.
<table>
<thead>
<tr>
<th></th>
<th>Local species richness (Average)</th>
<th>Farmland Species</th>
<th>Other Natural Species</th>
<th>Forest Species</th>
<th>Regional species richness (Average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWA - PWB</td>
<td>-0,1590214</td>
<td></td>
<td></td>
<td></td>
<td>-0,231</td>
</tr>
<tr>
<td>PW0 - baseline</td>
<td>-1,9692477</td>
<td>-0,0594</td>
<td>0,0031</td>
<td>-1,9130</td>
<td>-3,248</td>
</tr>
<tr>
<td>PWA - baseline</td>
<td>0,19303456</td>
<td>-0,1910</td>
<td>0,1432</td>
<td></td>
<td>0,2409</td>
</tr>
<tr>
<td>PWB - baseline</td>
<td>0,35205593</td>
<td>-0,0247</td>
<td>0,2254</td>
<td>0,1514</td>
<td>0,542</td>
</tr>
<tr>
<td>PWA-PW0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3,559</td>
</tr>
<tr>
<td>PWB-PW0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3,790</td>
</tr>
</tbody>
</table>

Table 8 Model outcomes for the Netherlands
Figure 4 Local species richness projected for each land use scenario in 2050: (a) Total species (b) forest species (c) farmland species (d) and other natural species. From left to right: Pathway 0, Pathway A and Pathway B.
‘Transition challenge’
To further articulate this ‘transition challenge’, we will first describe the current momentum of green niche-innovations and existing regimes in the Dutch land use system (chapter 3) and then compare these with the two future-oriented scenarios, described above. This will result in the identification of particular ‘transition challenges’ (chapter 4), which will then guide the development of actual qualitative scenarios (chapter 5 and 6).

3.1. Niche-innovations
Table 9 summarises the conclusions of the niche-analysis for the Dutch land use domain from D2.1. All the niches studied are examples of multifunctional land use: they combine different functions of land in an innovative way and are especially happening on the margins/edges of the existing systems. Rules and regulations do not always accept the combination what makes it for example difficult to implement new initiatives in existing spatial planning.

The table follows the relative ranking and assessment of current momentum of the studied niche innovations. Internal momentum refers basically to the speed of changes and size of the niche.
Table 9 Assessment of momentum of niche innovations in the Dutch land use domain (Zwartkruis, Westhoek, Kok, & Schoolenberg, 2014)

<table>
<thead>
<tr>
<th>Niche innovation</th>
<th>Main drivers of momentum</th>
<th>Pathway</th>
<th>Overall momentum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Business and biodiversity</td>
<td>Techno-economic:</td>
<td>B</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>- Number of participants in projects is rising (e.g. in 2014 around 500 (4%) arable farmers was part of the Skylark foundation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Dependent on the financial situation of the businesses involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Socio-cognitive:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Social network is increasing: new actors entering the market; big industrial players involved as well</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Commitment at businesses is increasing because of awareness of their dependency on biodiversity and the risks and opportunities that are associated with biodiversity for their business. They are aware they need to deal with biodiversity</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Learning is increasing: Community of Practice (CoP) to exchange ideas and knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Governance and policy:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Policy support is increasing: e.g. projects like The Economics of Ecosystems and Biodiversity (TEEB) are gaining attention and biodiversity is increasingly linked to economy.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Agricultural nature conservation</td>
<td>Techno-economic:</td>
<td>B</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>- The number of initiatives, farmers participating and land used for agricultural nature conservation is still increasing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Is about a new way of generating income</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- As it is about maintaining areas, money should be available during a longer period (it is not about an investment once)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Socio-cognitive:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- The network of people involved in urban farming is growing as more people are participating</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- The idea is that the amount of land used for agricultural nature conservation will further increase until 2020.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Governance and policy:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- It can be expected that only 25% of the farmers will apply agricultural nature conservation without subsidies, so farmers are still depending on policy support via subsidies.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Policy is changing: agricultural nature conservation will be organised in a collective way</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) Resilient landscapes: Room for the River</td>
<td>Techno-economic:</td>
<td>B</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>- Different options are available to develop more room for the river (it is technically feasible)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Socio-cognitive:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- NGOs, Rijkwaterstaat and land owners were able to connect to each other and realize their own goals leading to collaborative actions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Windows of opportunity for several policy domains came together (biodiversity goals, protection population against floods, creating nature)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Governance and policy:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 4) Local renewable energy production in the landscape | Techno-economic:  
- Number of projects is increasing: wind farms, biomass production, use of biomass from nature areas  
- New models are developed to pay investments in local cooperatives  
Socio-cognitive:  
- Need for renewable energy as fossil fuels will become scarce in the future, lead to geopolitical instability and contribute to global warming.  
- Social network is increasing as new type of organisations are entering the market: e.g. local energy cooperatives  
- NIMBY (Not In My Back Yard) effects of wind farms/mills  
- Competition with existing incumbent parties  
Governance and policy:  
- Regulations need to be adapted to new ways of organising energy production (e.g. taxes, etc.)  
- New ways to deal with spatial planning necessary | B | Medium |
| 5) Urban Farming | Techno-economic:  
- No business models available for the long term, and economic figures are not available  
- Number of initiatives is increasing  
Socio-cognitive:  
- Social network is increasing as many initiatives are popping up  
- Visions: A lot of promises for sustainability, however also a lot of uncertainties regarding the effects on sustainability  
Governance and policy:  
- No active policy support and spatial planning causes difficulties | B | Low |
| 6) Tourism (combining agro and tourism and nature and tourism) | Techno-economic:  
- Nature is a ‘social good’ (belongs to everyone and no-one), what makes it hard to reward it  
- Relatively stable market share in relation to other secondary activities of farmers  
Socio-cognitive:  
- The idea is that if people spend their spare time in nature, they will become aware of it and willing to help protecting the area  
- Tourism and nature conservation are separate worlds, hardly combined  
Governance and policy:  
- New collaborations often difficult to fit in regulations | B | Low |
3.2. Regime developments in the land use domain

The land use domain can be described as having multiple regimes. The niche innovations as described above (and in D2.1) are situated on the overlap between regimes, what makes that they have to deal with different regime developments at the same time. In the figure below (Figure 7) the different regimes and the position of the niche innovations is represented.

![Figure 6 Different land use regimes with the corresponding niche innovations](image)

The table below (Table 10) shows the assessment of the regime trends. Overall the regimes in the land use domain have a strong lock in. Changes are not really visible in the short term, as plants need time to grow, and especially forests take decades to develop. This invisibility in the short term, makes it sometimes hard to gather societal or public interest in changes, while the importance to do something with land use in order to reach the biodiversity goals for 2050 action is necessary, while the Paris agreement (COP21) asks for a bold new way of thinking on land use (Jepson & Schepers, 2016).

**Table 10 Assessment of regime trends in the land use domain in The Netherlands (with indicative ‘scores’) (Zwartkruis, Kok, & Westhoek, 2015)**

<table>
<thead>
<tr>
<th>Regime</th>
<th>Lock-in, stabilizing forces</th>
<th>Cracks, tensions, problems in regime</th>
<th>Orientation towards environmental problems</th>
<th>Main socio-technical regime problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>Strong</td>
<td>Weak to moderate</td>
<td>Moderate (some incremental change)</td>
<td>Large, long term investments</td>
</tr>
<tr>
<td>Nature</td>
<td>Moderate</td>
<td>Strong</td>
<td>Moderate (some incremental change)</td>
<td>Discussion on who has to pay for nature and how to reward it and uncertainty regarding subsidies.</td>
</tr>
<tr>
<td>Water</td>
<td>Strong</td>
<td>Weak</td>
<td>Limited; regarding floods, safety is still the main issue addressed.</td>
<td>Institutions have strong traditions/ways of working.</td>
</tr>
<tr>
<td>Urban</td>
<td>Strong</td>
<td>Moderate</td>
<td>Very limited (some attention for green in the city, but not much)</td>
<td>Build up area is not so much under discussion.</td>
</tr>
</tbody>
</table>
3.3. Landscape developments in the land use domain

In the external landscape we can make a distinction between destabilizing and stabilizing developments. The main destabilizing developments are climate change, increasing pressure on land, urbanization, the economic crisis, increasing demand of energy by households and digitalization of society. Furthermore external events like floods or animal diseases have an impact on land use as well. Recent policy changes have led to shifts in the policy on land use and for example the nature regime.

The main stabilizing developments are the fact that land use is hard to change as the character of land use is stable. The way land is used is not easy to change and investments, that are often large, have a long time horizon. Furthermore institutions are locked in, especially in the water and nature regime.

The main challenges related to multifunctional land use are dealing with biodiversity goals. Greenhouse gas emissions do a play a role as well, but the most visible direct effect is on biodiversity. The global goal is to stop the decrease in biodiversity.

Besides the Common Agricultural Policy (CAP), the main EU environmental policy frameworks that are influencing the land use domain are (OECD, 2015):
- The Nitrate Directive
- The Water Framework Directive
- The Birds and habitat Directive
- The Crop protection Policy (strong European base)
- The EU Biodiversity Strategy to 2020
- The EU Forest Strategy
- The Marine Framework Directive

Although a lot of policy is developed at the European level, every country within the EU has takes its own measures to meet the goals in the directives. In every country policy will play out differently, as the current land use and the characteristics differ per country.

3.4. Summary of current developments in the land use domain

To summarise the developments in the niches, regimes and at the landscape level, and to have an idea on the direction in which developments are taken place, the table below (Table 11) shows the potential for the niche innovations to break through. The studied niche innovations do have a low to medium momentum. It seems that niches are not really likely to break through and change the system in the coming decades.
Table 11 Breakthrough analysis of niche-innovations in the land use domain in The Netherlands

<table>
<thead>
<tr>
<th>Niche-innovation</th>
<th>Internal momentum</th>
<th>Strong, medium or weak alignment with broader regime characteristics and developments</th>
<th>Likelihood of imminent breakthrough (and/or future potential)</th>
<th>Pathway A or B (or mixed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business and Biodiversity</td>
<td>Medium</td>
<td>Strong</td>
<td>Growing and can break through in the future</td>
<td>B</td>
</tr>
<tr>
<td>Agricultural nature conservation</td>
<td>Medium</td>
<td>Medium</td>
<td>Stabilized niche</td>
<td>B</td>
</tr>
<tr>
<td>Resilient landscapes</td>
<td>Medium</td>
<td>Strong</td>
<td>Is incorporated in the existing regime</td>
<td>B (elements of A)</td>
</tr>
<tr>
<td>Renewable energy</td>
<td>Medium</td>
<td>Medium</td>
<td>Growing and can break through in the future</td>
<td>B</td>
</tr>
<tr>
<td>Urban farming</td>
<td>Low</td>
<td>Medium</td>
<td>Growing, but is not likely to breakthrough</td>
<td>B</td>
</tr>
<tr>
<td>Tourism</td>
<td>Medium</td>
<td>Medium</td>
<td>Niche that can grow, but will remain a niche</td>
<td>B</td>
</tr>
</tbody>
</table>
4. Specifying ‘transition challenges’

Before developing socio-technical scenarios, we articulate several tensions and contradictions between the quantitative scenarios from WP-1 (described in chapter 2) and socio-technical findings from WP-2 (described in chapter 3). These tensions form the ‘transition challenges’ between contemporary trends and developments, on the one hand, and the future changes that are needed to achieve the climate change and biodiversity goals. If current trends point in a completely different direction, this means that the transition challenge is large, which implies that drastic policies would be required to bend trends in the right direction. If current trends are already moving in the right direction, the transition challenge is less drastic, and mainly requires acceleration of ongoing dynamics.

Not all niche innovations studied in WP are part of the quantitative scenarios, since not all niche innovations can be modelled in terms of land use. For example renewable energy, but the tourism case as well. Recreation areas are part of the forest, nature and urban areas, and therefore hard to distinguish. However, the analysis of these developments does tell us something on the developments in the land use domain.

Table 12 describes these tensions for the innovations studied in WP2. Most of the innovations studied follow a Pathway B approach, as they focus on combining different functions of land. The last column also qualifies the transition challenges in terms of different kinds of constraints, using categories from Loftus et al. (2015): 1) technology readiness, 2) economics, 3) integration issues (in the current system), 4) social and non-cost barriers (both policy commitment and social acceptance).
<table>
<thead>
<tr>
<th>Innovation/ regime developments</th>
<th>Pathway A</th>
<th>Pathway B</th>
<th>Constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business and Biodiversity</td>
<td>Businesses do only take some measures to reduce their impact as a result of more stringent regulations, but only via sourcing their resources.</td>
<td>Businesses feel the urgency of dealing with biodiversity) issues and scarcity of resources (and are encouraged to do so by policy. Businesses take responsibility in the chain and help other actors in the chain (e.g. farmers) to maintain biodiversity (for example by paying a higher price and demanding extra measures). New business models are needed.</td>
<td>Economy (B), social acceptance (A), Policy (A and B)</td>
</tr>
<tr>
<td>Agricultural nature conservation</td>
<td>Agriculture is becoming more intensive and there is not much room for extensive agriculture or nature conservation on arable land. This niche will not develop further in Pathway A.</td>
<td>A mix of land use functions is rewarded and possibilities to safeguard biodiversity on agricultural land are taken.</td>
<td>Social acceptance (A and B)</td>
</tr>
<tr>
<td>Resilient landscapes</td>
<td>Technological measures to prevent flood in areas are taken.</td>
<td>Public safety goals and biodiversity goals are coupled, leading to new solutions.</td>
<td>Economy (B), technological readiness (A and B)</td>
</tr>
<tr>
<td>Renewable energy</td>
<td>Renewable energy is not part of the model scenarios for land use. However, an expansion of renewable energy can be expected. In Pathway A this is believed to be a new type of income for farmers that quit their business.</td>
<td>In Pathway B renewable energy will become part of multifunctional land use. It is an additional source of income for farmers. Furthermore renewable energy is locally arranged by actors in society.</td>
<td>Economy (A and B), societal acceptance (B)</td>
</tr>
<tr>
<td>Urban farming</td>
<td>In Pathway A urban farming is not expected to increase. There will be developed green areas in cities, as cities are growing and more people are going to live in the cities, but that will lead to urban nature and not to urban farming</td>
<td>Urban farming will increase. This is not so much influencing biodiversity or reduction of GHG emissions, but is helping to develop the connection between consumption and production of food.</td>
<td>Societal issues (B)</td>
</tr>
<tr>
<td>Tourism</td>
<td>Not part of Pathway A.</td>
<td>Tourism is used as an extra source of income for nature conservation organisations and farmers.</td>
<td>Societal issues (B), economics (B)</td>
</tr>
<tr>
<td>Rewilding vs mosaic landscapes</td>
<td>Separation of functions and areas only used for the activity that fits best. Area not suitable for agriculture will become nature: Societal acceptance is important: who decides on which areas are suitable for agriculture and in case this will be realised, we ‘decide’ that small scale farming on high nature value farmlands will no longer exist.</td>
<td>No rewilding, but combinations of functions (‘a bit of nature everywhere’). Combinations of functions: local and regional developments</td>
<td>Social acceptance Policy (A and B), Policy (B), economics (B)</td>
</tr>
<tr>
<td>Topic</td>
<td>Pathway A</td>
<td>Pathway B</td>
<td>Economics (A and B)</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Energy, food and wood are produced locally or regionally</td>
<td>Not part of Pathway A.</td>
<td>Business models need to be developed to make it attractive to produce locally</td>
<td></td>
</tr>
<tr>
<td>Agriculture is interwoven with natural corridors</td>
<td>Not part of Pathway A.</td>
<td>Measures are taken everywhere to maintain and protect biodiversity: this leads to lower production (as a result of less intensive farming) and therefore could lead to an increase in import</td>
<td></td>
</tr>
<tr>
<td>Green veining vs connecting areas (corridor)</td>
<td>Corridors: connecting large agricultural areas</td>
<td>Green veining</td>
<td></td>
</tr>
<tr>
<td>Multifunctional agriculture</td>
<td>Not in Pathway A: Pathway A is focussed on efficient production</td>
<td>- Way to get NGOs involved</td>
<td></td>
</tr>
<tr>
<td>Reduce agricultural land use</td>
<td>In PWA: focussing agriculture production on highly productive areas; other areas are used for nature, living etc.</td>
<td>In PW B: combining agriculture with other functions, in order to increase biodiversity all over the place. Compensation of farmers for secondary activities</td>
<td></td>
</tr>
</tbody>
</table>

Table 12 Tensions between future model scenarios for land use and WP-2 findings of niche-momentum and path dependencies
The socio-technical scenarios in chapter 5 and 6 aim to offer plausible pathways for how these transition challenges can be overcome via socio-technical interactions.

The transition challenges can be solved in two ways:
- Focus on other elements (for example focus on developing more nature instead of increasing the amount of intensive agricultural production land
- Change conditions (e.g. in the socio-cognitive environment, apply governance changes, etc.)

It does make sense as well to make a distinction between EU level and national level measures.

There are synergetic effects as well: e.g. the use of bio-energy is expanded to combat climate change, with positive effects on future biodiversity loss, but this also requires additional land and other resources with likely negative impacts on biodiversity in the short term (Van Oorschot et al 2010). Timing is important here: on the long term it can reduce climate change, while biodiversity is affected instantaneously.
5. Socio-technical scenario 1 (Pathway A)

5.1. Core characteristics, logics and challenges

This scenario provides a socio-technical storyline for pathway A from D1.3. In the PATHWAYS project this pathway is defined as focussing on large-scale technologies, which represent disruptive technical change, but leaves many elements of the socio-technical system intact. The main actors active in this pathway are the incumbent actors. In land use the main characteristics of Pathway A are:

- Large-scale technological optimal solutions (e.g. intensive agriculture and a high level of international coordination e.g. through trade liberalisation)
- Rewilding in areas that are less productive
- Technology based solutions: Enhanced crop and livestock productivity lead to a decrease in land use: applying technologies focussing on reducing external impacts such as pollution, and the use of biological techniques such as improved varieties and crops, biological control of pests, high productive tree species in plantations.
- Intensive agriculture: technology is key. Increasing productivity is necessary to get societal approval of ‘new type of rural areas’.
- Separation of land use functions: areas are used for one type of land cover, as that is most efficient. Agricultural areas are used for (high productive) agriculture and nature areas are used for nature (of high quality).

The major transition challenges concern (based on Table 12):

- Social acceptance: This Pathway asks for an emphasis on highly productive areas. That means that social acceptance is necessary for intensive agriculture and that typical types of agriculture in less favourite areas are no longer supported.
- Policy: In this pathway the CAP budget will decrease.
- Economics: Markets will get liberalized and subsidies will decrease. That asks for other business models to be able to earn an income and pay for maintenance of nature.

There are landscape developments expected that can assist niche-innovations or pressure regimes. In the following decades it is expected that the effects of climate change will become increasingly noticeable. For example for the Netherlands changes in the weather are expected. The temperature will increase leading to less cold winters and warmer summers. The amount of rainfall will increase both in winter and summer time. Hail and thunder will become more extreme, but the speed of the wind will remain more a less the same (KNMI, 2014). This asks for more resilient landscapes that can deal with weather extremes, as people have to be able to deal with more extreme weather (heavy showers or hail).

Furthermore the worldwide population growth, change in diets, an increasingly urbanized society and increasing competition on resources worldwide will demand changes of the current system.

In Pathways A the government will create an incentive to increase productivity and efficiency via more stringent regulations. However, the government support in terms of available budget is decreased and the markets are steering the developments. Spatial planning is however influenced by other developments; for example the developments in renewable energy or mobility.
5.2 Technologies and need for more societal acceptance (2015-2030)

Since the renewed Common Agricultural Policy (CAP) that has started in 2015/2016 the first ideas were collected to develop a renewed vision on the CAP after 2020. In Pathway A the choice was made in the CAP to reduce payments for High Nature Value Farmlands. The idea was to focus agricultural production only on the high productive areas. Separation of functions will increase: technologies are making it possible to increase production on agricultural areas, leading to rewilding areas at other spots.

Plans were made to reduce the CAP budget. The farmers in areas that are less suitable for agriculture areas were protesting. However, society was no longer accepting that a large part of the EU budget was spent on farmers. For the Netherlands the reduction of the CAP budget for less favourite areas did only lead to a minor decrease of CAP budget as there are only limited areas in the Netherlands making use of this budget. To compensate the farmers, there was still budget available for maintaining nature in the less productive areas. However, that budget was planned to decrease as well.

In 2020 a new strategic plan on biodiversity was developed, using the SDGs for 2030 making the connections between biodiversity and different sectors. In the Strategic Plan for 2030 of the CBD plan traditional nature conservation was put central.

Urgency was growing as risks such as diseases, decrease of soil quality and water quality and food safety are higher on the agenda and policy was urging the larger companies to deal with these issues.

Societal acceptance was important as society had to accept that only the high productive areas are used for farming, and typical local production areas were reduced. However, a reduction of less productive agricultural areas did lead to larger areas with ‘real nature’ and rewilding.

Since 2011 the lion share of the innovation policy was arranged via so called Topsector policy, so was the case for the agro-food sector. Via this instrument innovations are developed in public-private partnerships. The focus in this policy was very much on increasing efficiency and productivity and finding solutions to decrease the emissions.

High technical efficiency is the most important element of this pathway. This efficiency enabled export outside Europe of agricultural goods and services. The demand for renewable raw materials such as rapeseed oil and ethanol rises, due to the rapidly increasing price of fossil fuels and the strong growth in industrial production. Crop yields increase as a result of for example technical progress, improved seeds, better management, mechanisation, pest and disease control (PBL, 2014).

In the 2020s hot debates between long established environmental NGOs, traditional political parties and new but relatively strong political parties related to back to nature movement occurred concerning the design and goals of protected areas. While all agree on a doubling of protected areas, disagreement remains on whether to allow partial use of the areas or complete human exclusion (OpenNess, 2015).
**Regime developments**

The agricultural regime was strongly locked in. In the agricultural regime the focus was on increasing production. Because the budget of the CAP was declining and the markets were liberalized, farmers were encouraged to increase the production, however, with taking into account the environmental impact.

Higher inputs of capital (mechanisation), fertilizers and other chemicals can have negative impacts on biodiversity (PBL, 2014). Therefore technological solutions need to be found to limit the emissions of farms. These were mainly end-of-pipe solutions, for example closed animal systems with systems that clean the air. Production became increasingly more efficient and as a result of scarcity of fossil fuels and the improved technologies to adapt the amount of artificial fertilizer and pesticides used was reduced. As the amount of subsidies on the agricultural market decreased rapidly, farmers were producing increasingly for the international markets.

As a result of increased urgency to reach the goals for maintaining biodiversity and climate change and reducing further environmental impacts, environmental standards became more stringent, and the fines for not reaching the targets increased. Only the very efficient and highly productive farmers were able to reach the goals.

Besides the highly productive agricultural sector counter-movements started to develop in society. The gap between people living in the city and farmers producing food did became larger, not in the least place as a result of closed farms, and some social movements are demanding companies to open up. Consumerism became the leading life style all over Europe, and the majority of Europeans enjoy the benefits of the flourishing economy. The standards for quality of products did rise, as consumers wanted to have good and safe products in the supermarkets.

Regarding the nature regime, the reduced budgets asked for new ways to finance nature development. At European policy level, rewilding was recognized as a new conservation approach that is able to extend the scope and impact of EU nature policy in a cost-efficient manner, supporting a better implementation of the Nature Directives. One of the steps in this process was to change the status of wild bovids and horses, which were so far only recognized by law as domestic animals, while they are in line with species reintroduction policies. These animals showed to significantly contribute to ecological processes.

The area of nature started to slowly increase in some parts of the Netherlands, especially in the north eastern and eastern part of the Netherlands. As the distinction between nature and agriculture did became clearer, as a result of increased efficiency of agricultural production, the nature organisations in the Netherlands are developing rewilding areas in parts of the Netherlands. Although they were happy with the increasing amount of ‘real nature’ they need to find ways to find budget for maintenance of all these areas.

In the water regime the niche innovation room for the river did find its way into the water regime. This innovation, with many technological solutions was able to connect with the nature regime and thereby creating a good social ground for changes in the river landscape. It took a while, as the water regime was institutionalised locked in, but the niche became successful as it connected different issues simultaneously: flood protection and nature conservation.
Urban areas are growing. Since the 1960s the cities were losing popularity, but recently the population in cities grew faster than in smaller villages. That was mainly due to the increase in immigrants. An increasing amount of people was leaving the city, but they are living close by large cities. However, there was a movement from people from the rural areas (especially in the south, north eastern and southwestern part of the Netherlands) to the western part of the Netherlands. The main causes for the decrease in population in rural areas was that more families with children, young people and higher educated people are moving towards cities. In the less densely populated areas the number of jobs and facilities (like schools and shops) are decreasing. The number of people living in cities was increasing as well, as the number of immigrants in cities was growing. The build up area started to increase. However, the quality of the environment was getting more important as well, as the distance to green areas grew as a result of increasing urban areas. The attention for green areas in the city started to increase around 2025.

The environmental pressure was increasing and norms are becoming more stringent. The government was setting ambitious targets to reduce emissions on the one hand and was stimulating innovations at the other hand. This leads mainly to technological innovations, focussing on end-of-pipe solutions. Many technologies became available, for example using LED lights for growing crops, however society was hesitant. Furthermore the focus was mainly on increasing efficiency and production in the agricultural sector. Growing plants in buildings however, was not really accepted by the public as it was not perceived ‘natural’ by citizens and therefore resistance was growing. Related to this, the discussion on mega farms that started in the early 2000s did become important again. While society was opposing these kinds of developments, the environmental pressure on the agro-food sector was asking for technological solutions to produce in a more efficient way. While companies are improving technologies, society seems to remain behind. Around 2020 it becomes clear that measures should be taken to reach the goals. The government was trying to influence the social acceptance of this type of technologies. The NGOs played an important role in realising this increased awareness. Geo-political issues had a large impact on the Dutch markets and increased the need to focus production as much as possible in the Netherlands. As an important player in the in- and export of food and agricultural products, the Dutch agri-food sector was suffering from these issues.

Society was afraid for the risks of concentration agricultural production, in a very intensive way, at certain places, as that can lead to increasing pressure by pests and diseases.

Knowledge development in all regimes was focussing on technology to solve issues with biodiversity, land use and emissions. The focus was on increasing agricultural production and technological solutions to deal with more extreme weather and landscape conditions.

Niche developments
The niche innovations that started to gain momentum in this period are rewilding and renewable energy. As a result of increased efficiency in agricultural production areas were more and more used for agricultural production or nature, and these functions were separated. In the agricultural regime, policy was focussing on sustainable intensification. Budgets for multifunctional land use were decreasing. Rewilding did take place in the nature areas. In order to pay the maintenance of the area, tourists were attracted by nature conservation organisations.
Another niche that gained momentum was ‘renewable energy’. The increasing demand for food, the increasing efficiency of renewable energy production and the decrease in the amount of land used for growing crops created opportunities for people in the rural areas to develop ideas for renewable energy production. Scarcity of fossil fuels and geopolitical issues did feed this development as well, so the urgency to increase national renewable energy increased rapidly. Furthermore the niche was a solution for farmers that need to look for other types of income and did fit in the landscape as well.

The momentum for the room for the river niche was already medium in 2015. The water regime needed extra policy in order to find nature based solutions to deal with increasing water levels and climate change, so therefore the Room for the river niche did became part of the policy on water in the Netherlands and therefore can be seen as part of the water regime.

Besides these niche innovations, the attention was mainly on technological developments and nature based solutions in agriculture.

5.3. From CAP to innovation policy (2030-2050)

In 2025 it seems that the Sustainable Development Goals, as agreed upon in 2015, and the Aichi targets were not reached, so the urgency increased something has to be done in order to stop the decrease of biodiversity and reduce the GHG emissions drastically. More ambitious goals are set (1.5 degree target instead of 2 degree) by the European government and via regulation actors in the land use domain are forced to reach these goals. The focus was on technocratic solutions, but there was a risk that technologies will be seen as solutions to limit the impact on the environment, while that was not enough too reach the goals.

The degradation of ecosystems in some European regions pushed technical solutions to their limits and require increasing amounts of money. Increasing environmental problems motivate the transition from fossil fuels to renewables, with a strong focus on technical solutions and less on bio-based options. Simultaneously, the growing demand for provisioning services such as agricultural commodities and base materials was satisfied by imports from outside Europe, triggering an increase in agricultural areas outside Europe. This development also balances to some extent the huge trade surplus based on the export of industrial products and technologies (OpenNess, 2015).

Around 2030 the decision was made to end the CAP budgets. CAP transforms in a policy to stimulate technological innovation to reduce the impact of agriculture. Furthermore rewilding was increasingly seen as an opportunity for conservation policy to shift gear from protecting and designating to restoration that ‘up-grades’ ecosystems, improves network connectivity and creates new value for people (Jepson & Schepers, 2016).

Nature policy was increasingly decentralized: provincial authorities are allowed to develop their own plans regarding nature policy.

Regime developments
As the issues with biodiversity are becoming more prominent the societal acceptance for large scale agricultural production for international markets decreased. NGOs were raising questions on why the soils in the Netherlands are exhausted in order to produce for the world
market. The answer of policy was that it is important for the export position of the Netherlands. The Netherlands was still an important exporter in the world agricultural trade, and would like to keep that position. That means that as a kind of opposite of the very productive agriculture, there must be very high quality nature areas in order to still reach the targets for biodiversity and GHG emissions. The market and international trade in agricultural products remains important. The smaller farms have difficulties to survive.

The idea to separate agricultural production and nature started to become more institutionalised. The two functions became physically and instructionally more separated. The growth in productivity in agricultural areas made that other areas could be used for nature (including forest) and rewilding.

**Niche developments**

A niche that has started to develop was urban nature. As a result of the increasing urban areas (a growth of 52%), there was more need for developing green areas in or close to build up areas. There was hardly any area suitable for farming close to cities, and as people do want to have some green areas in their surrounding, nature areas are developed close to cities and green areas in cities are developed as well. Rewilding in urban and peri-urban areas did meet these demands. Degraded industrial, mining and agricultural land close to cities was developed into new nature-based attractions. The rural areas became less populated. As a result of the decreasing subsidies for less favourite areas, many areas unsuited for mechanised and competitive agriculture were experiencing land abandonment and outward migration, particularly among young people. These developments led to a decline in rural culture and the decreasing biodiversity-rich habitats. Subsidy mechanisms were too costly and not suitable on the long run, so rewilding developments were a solution to tackle these problems. Rewilding was able to engage with these types of landscape dynamics in a positive, creative and investment-oriented way (Jepson & Schepers, 2016).

A more productive agricultural sector leads to more rewilding: areas only used for nature. Rewilding was seen as a solution in case of piggybacking; in case it can profit from other functions, like water safety or flood protection. However, in the case of room for the river there turned out to be boundaries to ‘impact for biodiversity’. Flood protection was still the main goal and therefore biodiversity could benefit from measures taken as long as the measures focus on flood protection.
6. Socio-technical scenario 2 (Pathway B)

6.1. Core characteristics, logics and challenges
This scenario provides a socio-technical storyline for pathway B from D1.3. In the PATHWAYS project this pathway is defined as focusing on a wider set of changes across several system dimensions in which new entrants play an increasingly large role. Wider shifts in cultural discourses and social legitimacy emerge, which are supported and support a broader, inclusive governance approach (beyond large firms and technologies), reflecting deeper changes in policy paradigms.

The main elements of Pathway B in the Dutch land use domain are:
- Mosaic landscape, green veining, multi-functional land use
- More conservation of biodiversity on agricultural land and in managed forests.
- Improved agricultural productivity is achieved through ecological intensification methods, using a mixture of techniques including mixed cropping, optimising natural pest control such as Integrated Pest Management
- Focus on local and regional developments
- Ecosystem services are gaining importance

The major transition challenges concern (based on Table 12):
- Social acceptance: Social acceptance is necessary in order to combine different functions in one area. This asks for different types of management
- Policy: In this pathway the CAP budget will decrease, but less fast compared to Pathway A. The CAP will change into Common Agriculture and Food Policy, leading to a systems’ approach.
- Economics: Business models are needed to finance the new combinations of functions in the land use domain.

The landscape developments that are expected to force the developments are the increasing effects of climate change (KNMI, 2014), the worldwide population growth, change in diets, an increasingly urbanized society and increasing competition on resources worldwide (EEA, 2015).

6.2. Changing consumption, perception and move towards ecological intensification (2015-2030)
The changes in consumption patterns (more animal products) in Europe, the goals set to halt the decrease of biodiversity and the increasing pressure on land made that solutions are searched for by focussing on ecological solutions in multifunctional land use, in which different functions of land use did become combined. The focus was on local solutions and trying to involve society with nature, in order to increase the willingness to pay for nature.

Consumers were slightly getting more aware of the impact of food consumption on the environment as a result of successful campaigns by NGOs. The shift in preferences towards a reduction of consumerism has especially strong effects. Much of agricultural production converted into organic farming or sustainable integrated farming and reduced consumption of animal products and increased productivity of ecological farming lower the pressure on land resources. Furthermore, ecosystems approaches were mainstreamed into agricultural, water and forestry policy to ensure sustainable use (OpenNess, 2015).
The meat consumption in the Netherlands continued to decline. However, the effects on production of animal products are not yet visible in the Netherlands, as a large part of the production was exported to other countries in Europe. However, the production was becoming less intensive as a result of more stringent environmental measures from 2020 onwards. At that point it became clear that measures are needed in order to meet the SDGs and new goals were set in the New Strategic Plan on Biodiversity. The SDGs are goal setting, however the way to reach the goals was not chosen yet.

Part of the Dutch system was influenced by European decisions. The CAP had a large reform in 2020. The budget remained more or less the same, but the CAP changed into a Common Agricultural and Food Policy. The focus was on encouraging multifunctional land use and not so much more intensive production methods. In that approach farmers are seen as part of the solution to increase biodiversity and reducing GHG emissions. Farmers got a role to maintain the landscape.

Dutch innovation policy was no longer focussed on technological innovation, but rather on ecological intensification. Ecological intensification aims at designing multifunctional agroecosystems that are sustained by nature, by making use of natural functionalities that ecosystems offer and sustainable in their nature (Tittonell, 2014). This demands a landscape approach and requires collective decision making, which calls for institutional innovations. Furthermore policy stimulates value creation in the chain and tries to involve more actors throughout the value chain. In general the focus of policy has changed from focussing on production towards food and ecosystem services.

Decentralisation of policy regarding nature conservation led to a change of focus. The focus was on local and regional ideas, by making local organisations in charge for nature conservation. Also in the CAP the focus was more on local developments.

Regime developments
The regimes in the land use domain have a strong to moderate lock in, mainly caused by large and long term investments and institutionalised lock-ins. Cracks and tensions are mainly caused by changes in policy on both European level (CAP) and national level (more decentralised policy). Budgets were decreasing what made actors looking for other ways to finance their activities. There was a need for more and better business models to calculate the true prices of products and deal with the decreasing budgets for nature conservation. In this Pathway the social awareness was increasing, leading to new opportunities to finance nature and biodiversity via products.

In the water regime there are hardly any cracks and tensions. Flood protection was arranged in room for the river projects and accordingly coupled with nature conservation.

In the agricultural regime the incumbent actors were trying to change their role in the value chain. That was however hard, as the chain was locked-in as a result of price wars on products. However from 2020 onwards more consumers are willing to pay a higher price for improved quality: direct product quality or quality of the environment. Saturation of markets for food products and the pressure on prices make that farmers are looking for other ways to sell their product: for example by giving attention to production methods, quality, or ecosystem services.
An increasing number of experienced and new farmers and cooperatives start to diversify production, at lower levels of land-use intensity and mechanisation. Initial difficulties make imports of agricultural commodities from outside the EU necessary. Europe’s temporary agricultural imports only partly compensate for the huge amount of feed and other products imported before the crisis, causing a net reduction in trade and revenues outside Europe (OpenNess, 2015).

The nature regime was looking for new ways to finance nature as budgets were declining. It was however hard to find new ways to gain budgets.

**Niche innovations**
The more extensive production methods, like organic farming are also induced by new policy that aimed to make it easier to change from a conventional production towards organic farming. While in the 2000s this was a huge and expensive hurdle to take for farmers, from 2017 onwards it became more attractive to make that step. Agricultural nature conservation was growing in importance. Combining agriculture and nature was seen as one of the solutions to maintain and improve biodiversity.

Large companies like Heineken were starting to get more aware of their impact on the environment and the niche business and biodiversity became larger. This was partly because of the increasing scarcity of resources, but also NGOs confronted companies with their responsibilities to maintain nature and biodiversity. New business models were developed that calculate the price of products with taking into account the impact on the environment. True pricing was getting more prominent and once a couple of large players in the food business are using ‘true prices’ others follow soon. NGOs have an important role by naming and shaming the ones lagging behind.

Nature became perceived as solution from a market orientation. This was encouraged via policy, the market and consumer choices. However, new business models are not there yet and needed to be developed.

The gap between consumers and the production of food was very large. As a result of the increasing amount of diseases related to farming and problems with resistant bacteria, consumers became more willing to know where and how their food is produced. This was an opportunity for local farmers to profit from. The slightly higher price for products is used in the area the production took place. Another related niche that was increasing in momentum was urban agriculture. Although this trend did not have a large impact in terms of biodiversity conservation or lowering emissions, it did play a role in social cohesion and redeveloping the connection between food production and consumption. Furthermore it made people more aware of the environment they live in and thereby increased the attention for green areas and nature. In cities more green areas are developed and people are enjoying nature.

Renewable energy was getting more important. Geopolitical issues with some of the most important oil countries made that the Netherlands wanted to become less dependent on fossil fuels. The subsidies for renewable energy increased, although there was still a lack of social acceptance. NIMBY (Not In My Backyard) was an important problem: people were not willing to have large wind turbines in their surroundings. However on the other hand local initiatives popped up in which people together organised renewable energy in their village or city. In so-called energy co-operations they collected funding for wind turbines or solar...
panels, which are used on the roofs of municipality buildings. This also fits the developments towards a more locally organised community that was trying to become less dependent on global resources. Furthermore wind turbines are a good alternative source of income for farmers: as agricultural production was no longer becoming more intensive and the amount of payments was reduced, renewable energy was a very welcome source of income. Another way for farmers to get a higher income was tourism. This kind of secondary activities was gaining popularity. A growing demand for ecosystem services, related to tourism and recreation, started to develop. Simultaneously, an alliance between agrarian and industrial lobbies additionally weakens policies protecting the environment and preserving nature (OpenNess, 2015)

Tourism was also in another way effecting land use practices. Developing and especially maintaining nature needs to be paid. The number of members of nature organisations was declining, so other ways to get a budget needed to be found. By asking an entrance fee, parts of the costs are covered. However, that seemed not to be the solution, as people are not willing to pay fee for every time they spend their leisure time in nature.
However, a side effect of tourism was that human activities can have negative effects on nature and biodiversity through disturbance of the remaining natural and semi-natural areas. Fragmentation, for example by roads, does lead to a decrease in number of species that require large areas (PBL, 2014). Solutions to prevent this kind of effects needed to be found in the next years.

NGOs are playing a more important role in connecting different functions of areas. Stichting Ark (Association involved in Room for the River) was an example of an organisation that was able to connect public safety and nature conservation in projects focussing on water.

6.3. Multifunctional land use (2030-2050)
Most of the environmental movements and NGOs supported national governments and the EU administration in their efforts to develop and adapt environmental legislation. However, the unsuccessful trials of participatory policy design at the EU level, due to immense administration and considerable limits in feasibility. While the EU continues to be a strong actor, its role changes towards an institution which facilitates regional approaches and pan-European knowledge exchange (OpenNess, 2015).

The reform of the CAP did lead to more multifunctional land use. However it seemed that the goals regarding biodiversity are not easily met. Therefore more stringent measures are taken that force actors to reduce the impact on land and biodiversity.

After the European economy and many EU institutions dwindled in the late 2020s and early 2030s, Europe has been losing power and many of its leading roles in politics and the economy. However, many branches of the back to nature movement have been wise enough to coordinate the countless applications and research in re-establishing and promoting numerous of the well adapted varieties of almost forgotten crop types, vegetables, fruits, old livestock races and sustainable management strategies on regional and national levels. Some of the larger cooperatives gain importance in Europe and beyond in production and distribution of robust seeds, livestock, but also technologies adapted to sustainable production. While successful regional organisations / cooperatives are increasingly trading with similar cooperative organisations, which are gaining popularity in other parts of the world, some of the less organised regions seem to be left behind. In contrast, many of the large multi-national companies and agro-industries move out of Europe, while several others adapt strategies, technologies and company structures to better match new demands and
markets. After the recovery of the restructured economy, inner-European and international trade slowly increases to moderate levels (OpenNess, 2015).

Regime developments
The SDGs became more important, as the goals were not reached yet in 2025. Therefore Europe decides to set more stringent targets: the 2 degree target became a 1.5 degree target. That urged actors to take action. More stringent environmental measures were taken and goals were set on biodiversity as well.

Urban areas were increasing, but less fast compared to Pathway A. The amount of semi-natural areas increased by 5%, while forests decrease with 6%. These changes were the result of an increase in multifunctional land use.

Policy was mainly focussing on combinations of land use.

Niche innovations
Farmers were framed as caretakers for the landscape, plants and animals got an important function in the landscape in relation to biodiversity. The biodiversity on agricultural land increased and both large food producers and consumers became willing to reward the extra measures taken to increase biodiversity by producing food. The main challenge of multifunctional land use was that new business models were needed to reward ecosystem services. Collaborations between big food companies and retailers helped farmers to increase biodiversity on their land and the external costs became part of food prices. That made it possible that businesses are paying for nature conservation and ideas like business and biodiversity are getting more important.

NGOs also played an import role in increasing consumer awareness regarding environmental issues related to consumption. A larger group of consumers became willing to pay higher prices for quality, food safety and taste. These higher prices can be used for decreasing the environmental impact and taking measures to prevent biodiversity loss as result of production.

Urban farming became more popular, but also had its backside effects. Production in urban farming was limited and due to increasing environmental impacts of for example fine dust in cities there are risks related to food that has been produced in cities. However, the amount of green areas in cities increased as a result of people wanted to have green surroundings.

A combination of functions was rewarded by policy. Solutions to decrease emissions are found in nature based solutions; however it was hard to reach the goals in that way.

The size of the area used for agriculture increased and productivity will increase as well in order to be able to feed the world.
7. Conclusions

In the previous two chapters we have described the scenarios for Pathway A and B, which meet the targets. However, both scenarios deviate substantially from business as usual scenarios. It is however hard to realize a transition in the land use domain, because of sunken costs, allocation of land use and the influence of natural elements like climate change on land use. Furthermore land use is influenced not only by policy on land use, but also by developments in other domains, like mobility, energy and agro-food. As the transition challenges described in Chapter 4 shows, both pathways require substantial reorientations of current trajectories. However, changes are occurring very slowly, partly due to the nature of the land use domain and partly because changes in for example regulations are very hard to organize. The challenges are mainly in economics (how to pay for nature development), policy (decisions taken on different levels) and social acceptance (for example whether or not using EU budget for farmers, maintaining particular local production). However transitions can be made if relevant actors change their commitments, strategies, investments, and behaviours.

Similarities and differences in transition pathways

In the table below (Table 13) some of the main elements of both pathways are described and compared.

<table>
<thead>
<tr>
<th>Elements of Pathways</th>
<th>PW A</th>
<th>PW B</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAP</td>
<td>Decrease in budget</td>
<td>Budget remains more or less the same</td>
</tr>
<tr>
<td>Knowledge and innovation</td>
<td>Improve current developments: more efficiency</td>
<td>Broader knowledge base; more attention for business models</td>
</tr>
<tr>
<td>Technology</td>
<td>Hard technological solutions</td>
<td>Nature based solutions</td>
</tr>
<tr>
<td>Consumers</td>
<td>more stringent standards for products</td>
<td>extra attention for what is more than the standard</td>
</tr>
<tr>
<td>Chains</td>
<td>Global chains</td>
<td>Regional and local chains</td>
</tr>
<tr>
<td>Environmental policy</td>
<td>Stringent environmental policy and steering on innovation</td>
<td>Stringent environmental policy and steering on behaviour</td>
</tr>
<tr>
<td>Spatial planning</td>
<td>Separation of functions, land abandonment</td>
<td>Multifunctional land use, fit in the landscape is more important</td>
</tr>
<tr>
<td>Markets</td>
<td>Global dynamics</td>
<td>Regional markets, decentralised societal debate</td>
</tr>
<tr>
<td>Sustainability approach</td>
<td>Sustainable intensification</td>
<td>Ecological intensification</td>
</tr>
</tbody>
</table>

Table 13 Similarities and differences in transition pathways

The main similarities and differences between the two pathways A and B are:
- The amount of built-up area will increase, although the size of the increase differs.
- Pathway B is focussing nature based solutions, while pathway A is focussing on limiting the risks and prevents the largest impact by technological solutions.
- In Pathway A the budget of the CAP will increase, while in Pathway B the budget will remain more or less the same.

Policy risks

Countries need to take their responsibilities and do commitments in order to reach these targets. Decisions had to be taken on how to reach the goals. For example the SDGs are goal-setting, but the way how to reach the goals is not clear.
One of the risks is that social acceptance is hard to mobilise. It does take some time after measures are taken that biodiversity is increasing (as it takes time for example for trees to grow and reproduce). Therefore it is difficult as well to get actors motivated to take action, as the result is on only visible on the long run. The same counts for farmers: it is harder to take measures that are costly, when the effect of the measures on for example soil quality will only be visible in a couple of years.

A second risk is that technology development to increase efficiency develops slower than anticipated and does not contribute as much as is anticipated. Especially the Netherlands is already a very productive country in terms of agricultural production, so the question is how much growth is possible.

In order to make something happen in the locked in land use regimes, very stringent governmental measures are needed. Changes in land use occur slowly and therefore effects will only be visible in long term.

In Pathway B the routes to reach the goals are limited and it is even the question whether goals will be reached. The niche innovations in Pathway B have hard times to increase momentum, as overall the Dutch policy on land use has a Pathway A focus. Only if it possible to connect with other goals, like in the case of room for the river, it will be possible to develop multifunctional land use as a solution to reach the targets.

**Wider policy implications**

Based on the scenarios we can draw broader policy implications. The urgency to speed up ongoing developments and strengthen commitments is high. Both scenarios require major reorientations and decisions on that reorientation need to be taken soon, in the coming decade.

Both scenarios ask action from policymakers. In both scenarios more stringent measures on reaching the emission targets and biodiversity goals are needed. In Pathway A these measures will be combined with innovation policy encouraging technological innovations to reduce emissions, while in Pathway B the focus of policy needs to be on bringing partners in the chains together in order to take responsibility regarding improvements and combine different goals and functions.

Social acceptance is the third point that needs attention. Whatever decision is made, social and cultural dimensions need to be taken into account in order to make them work out. Land is visible everywhere and people do have an opinion about it. Liveability of the area people live in is important as well, and therefore society should be taken along in decision making.
8. References


