Chapter 4
Transition and Transformation

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Contents

Abstract In this chapter it is argued that fundamental change in society is required, because environmental problems are serious and ask for a factor 10 or more shift in society, the resilience approach (as outlined in Chap. 2) implies change to higher

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R. Roggema (ed.), *Swarming Landscapes: The Art of Designing For Climate Adaptation*, Advances in Global Change Research 48, DOI 10.1007/978-94-007-4378-6_4,

resilience systems and current spatial planning is unable to facilitate fundamental change. Transition of an existing system into a better version of the same system does not comply with the demands of fundamental changes. Instead of choosing for the pathway of change, a change of pathway is required. This transformation of the existing stable regime (system A) into a fundamental other regime (system B) is able to meet the urgency to change. However, Transformation of a system is only possible when the new system is fundamental separated from the original and is capable to develop its own growth curve. The proposed pathway courses via B-minus. A predecessing state of system B consisting of rudimentary spatial elements, which can be observed as critical early warning signals and can be created at specific intersections in the network. These signals require a spatial translation to become useful in spatial planning. Network analysis is needed to determine the locations where to create starting points for a system change.

Keywords Transformation • Transition • Spatial planning • Networks • Early warning signals

4.1 Introduction

"Contemporary environmental problems, such as climate change, loss of biodiversity and resource depletion, present formidable societal challenges. Addressing these problems requires factor 10 or more environmental performance, which can only be realised by deep-structural changes. These systemic changes are often called socio-technological transitions" (Geels 2011). These 'system errors', as Rotmans calls them are "flaws in our societal system, which cannot be corrected through market mechanisms: weak networks, fixation on technology, ingrained behaviour, institutional constraints and path dependencies" (Rotmans 2005). In dealing with uncertainty the resilience approach is, as pointed out in Chap. 2, found valuable, e.g. a certain area or system needs to increase its resilience in order to deal with uncertain circumstances. Both, environmental problems and resilience imply fundamental change. Many elements, undergoing these changes are embedded in spatial planning, plans or processes. However, the way these changes can be reached depends largely on the approach. Is the process seen as a pathway of change, a gradual smooth change, a transition process is useful, but if a change of pathway is required a transformation is more obvious. Both approaches are addressed in this chapter.

4.1.1 Resilience

The concept of resilience (Walker et al. 2004) has mainly been used to study socio-ecological systems (amongst other: Olsson et al. 2006; Wilkinson et al. 2009; Cork 2010). Notwithstanding the major contribution these works deliver in understanding the resilience of the Earth system and other socio-ecological systems, the (potential increase of) resilience of spatial systems such as cities and landscapes is less extensively studied.

The Earth system (Lenton and Van Oijen 2002; Lovelock 1988) and spatial systems, such as landscapes and cities are defined as complex adaptive systems (Allen 1996; Portugali 2000; Batty 2005), which in principle make them suitable for resilience thinking. Moreover, complexity is increasingly seen as a fundamental theory for spatial planning (Innes and Booher 2010; De Roo and Porter 2007).

The adaptability, e.g. the collective capacity of actors in the system to manage resilience (Walker et al. 2004), of spatial systems is determined by the collective capacity of spatial elements to manage resilience. Here, spatial elements are defined following Dalton and Bofna (2003): "Elements of zero, one, and two dimensions that observers acquire and utilize as anchors for location (…). Not only can the observer position himself in space in terms of basic topological relationships ('to the front of', or 'to the right of') but also 'at', 'on', or 'inside' them". Hence, spatial elements have the collective capacity to manage resilience, which allows spatial systems to increase its resilience.

4.1.2 Change in Current Spatial Planning

Spatial planning practice has major difficulties to facilitate fundamental change, as it is not used to major shifts and changes. This can be illustrated using the three most recent regional plans (Provincie Groningen 2000, 2006, 2009) for the Groningen province area in the Netherlands. The changes in aims, policies, chapters, and maps are marginal. Once policies are defined in the first plan they are repeated to a large extent in the second and third plan. When the functional maps of the first and third plan are compared a modest 2% of the entire area is allowed to undergo any functional change over a period of 13 years. This example illuminates the 'incre*mentality*' that is manifest in many spatial plans, at least in the Netherlands. These incremental changes in the consecutive regional plans can be visualised as a straight, slowly rising line on which identical waves of planning processes follow each other (Fig. 4.1).

The small changes that are the result of these consecutive spatial plans do not meet the needs for fundamental changes. A preliminary design, in which the required changes to adapt to climate change are integrated shows that approximately 30% of the land area needs to potentially undergo a functional change (Roggema 2007), far more than the 2% that is allowed.

Given the required changes, as a result of the type of problems society faces and as a result of striving for higher resiliency, and the inability of current spatial planning practice to incorporate change, the search for a fundamental new planning approach is necessary. This new planning framework (Roggema et al. 2012), is capable of identifying the required changes and will be elaborated on in Chaps. 6 and 7 of this book. The question, once we know what we want to achieve, how to reach this changed future is discussed in this chapter.

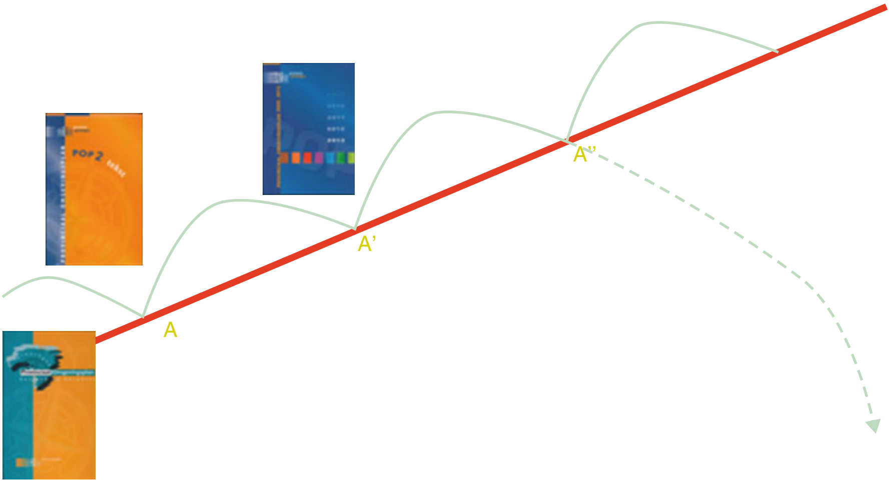

Fig. 4.1 Subsequent plans of the same ‘family’ as consecutive waves

4.2 Transition

4.2.1 Three Horizons of Change

Once it becomes clear that a planning approach, which operates in terms of end images for the future is not suited to resolve the longer-term dynamics of climate change and energy supply, alternative pathways are to be explored. These alternative pathways do not take a certain end-result as the main focus, but the process or the transition towards an uncertain future. However, before this pathway can be determined the question is which uncertain future we want. As demonstrated by Newton (2008) in his 3-horizons model, the more sustainable futures take a longer period to implement (Fig. 4.2) and as such determine the pace and path of the transition.

4.2.2 Transition Phases

In recent literature the change from a certain state or regime towards another (more sustainable) is described as a transition. A transition is defined as “a gradual, continuous process of societal change, changing the character of society (or a complex part) structurally” (Rotmans et al. 2000). This transition is generally represented by a fluent curve (Fig. 4.3) and divided into four phases: pre-development, take-off, acceleration and stabilisation.

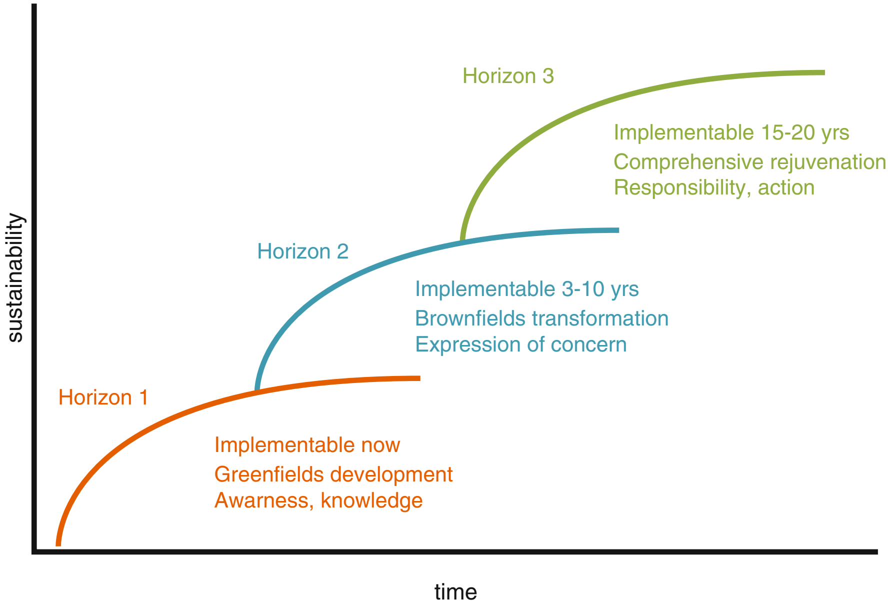

Fig. 4.2 3-Horizon thinking (After Newton 2008)

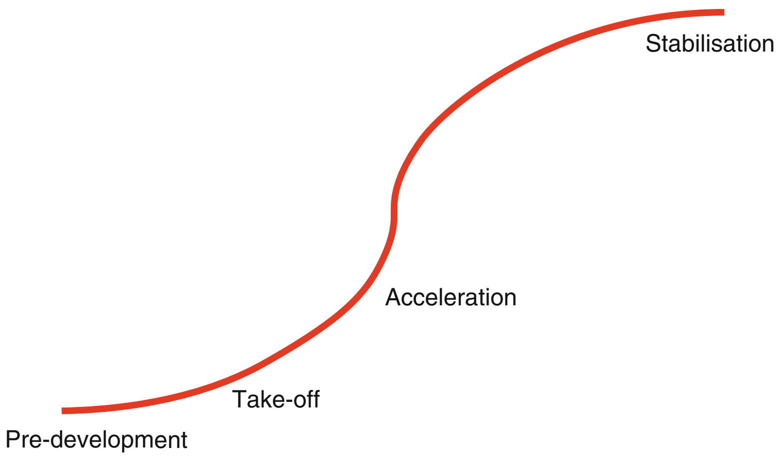

Fig. 4.3 Basic phases of a transition (After Rotmans et al. 2000)

De Roo (2008) elaborates on this and attributes dynamics to each of the distinguished phases (Fig. 4.4): between the two stable phases a dynamic phase enables the system to shift from an old (weak) context towards a new (stronger) one.

Various studies on change management argue that this change can only take place if a crisis has been experienced (Hurst 1997; Peters and Wetzels 1997; Homan 2005; Zuijderhoudt 2007). Corresponding schemes all describe this transition as a

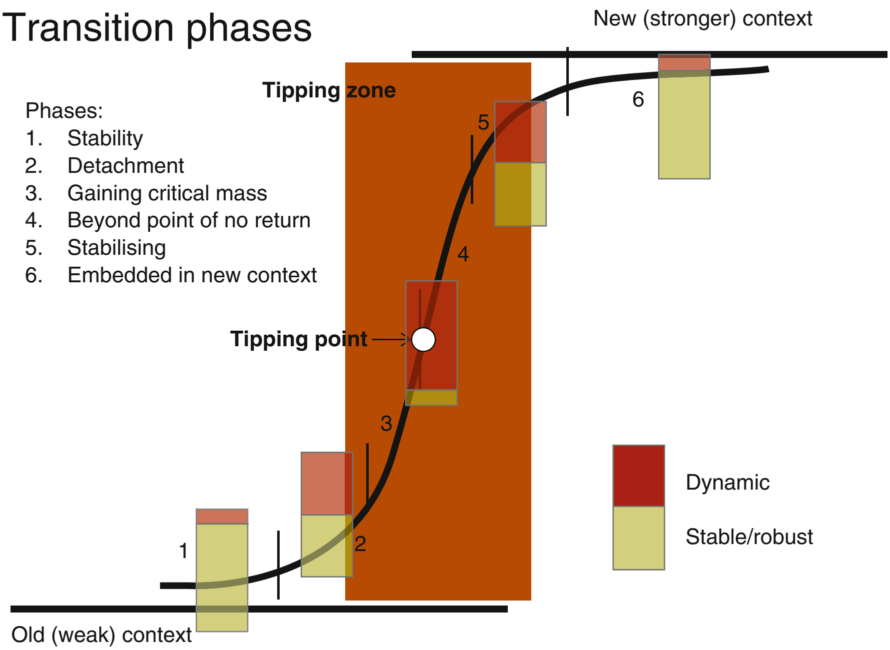

Fig. 4.4 Dynamics of different transition phases (Source: De Roo 2008)

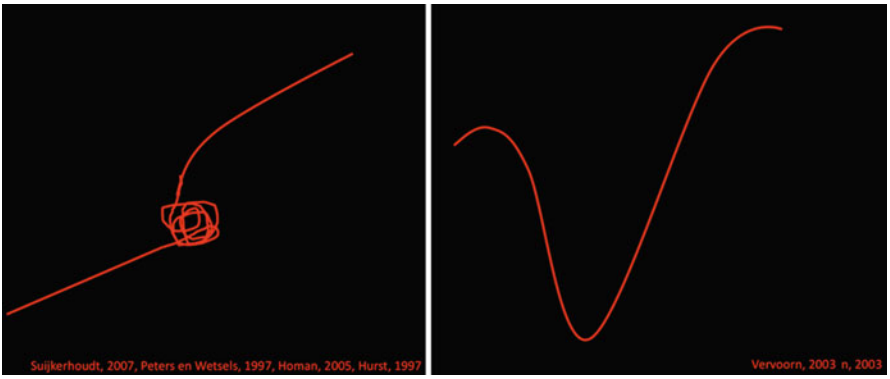

Fig. 4.5 A crisis before reaching a new level (Source: Zuijderhoudt 2007; Hurst 1997; Peters and Wetzels 1997; Homan 2005 (*left*), Vervoorn 2003 (*right*))

fluent line up to a certain point where chaotic circumstances appear. Out of this chaos a new fluent line emerges (Fig. 4.5). Moreover, during times of change, there is no such thing as a quick fix, as Vervoorn (2003) demonstrates, using Dante's *Divina Commedia* as a metaphor (Fig. 4.6 and Box text): society needs to create a very clear, imaginable and attractive image of the future vision before it can leave the old behind and learn, while experimenting the new.

Box Text

The narrative Hans Vervoorn uses to explain transition, tells the story of Dante Algieri seeking for his beloved Beatrice: "Dantes Divina Commedia describes the process that change only can take place if a crisis has been experienced before. In the middle of my life, Dante writes in 1315 in the first paragraph of chapter one in La Divina Commedia, I lost track and ended up in a fearful overgrown and dark wood. In our times we would say: I am in deep trouble. Somewhere, far away, Dante sees a sunny hill, where he would like to jump to. Nowadays we would say: you're in denial, because there is seldom a quick fix. It is impossible for Dante to jump to the hill, because three wild animals are making trouble. These animals represent the three basic human fears for change:

(a) The lion stands for pride. The basic fear is ego hurting: the fear that, in case of change, you are accused you did things wrong before.
(b) The panther stands for flexibility. The basic fear is that you are thrown out of your comfort zone in case of change. The fear that you need to do things you never did before and are not yet capable of.
(c) The wolf stands for greed. The basic fear is that you are threatened in your status, position or welfare. In great fear he calls God for help, who sends, as a Deus Ex Magina, Vergil, a poet in the early Middle Ages, for whom Dante has great respect. Vergil says to Dante: I have some good and bad news for you:

The good news is: I will get you out of this dark forest and will bring you to Beatrice (a very beautiful girl from Firenze, with whom Dante fell in love with in his youth and wrote many love-poems about) and with her you will reach Heaven, the dream of every Christian.

The bad news is that our pathway will lead us through hell (a metaphor for de-learning, get rid of the old) and purgatory (learning the new while experimenting).

In de rest of his book Dante describes exactly this pathway. The moral of this story is:

In times of change you need a coach, an advisor (Vergil) who helps Dante (society) during the process. The first thing society (Dante) needs to create is a very clear, imaginable, attractive image of the vision, the ultimate dream and final image (Beatrice), before society can overcome its basic fears, leave the old (Hell) behind and learn (Purgatory), while experimenting the new." (Vervoorn 2003)

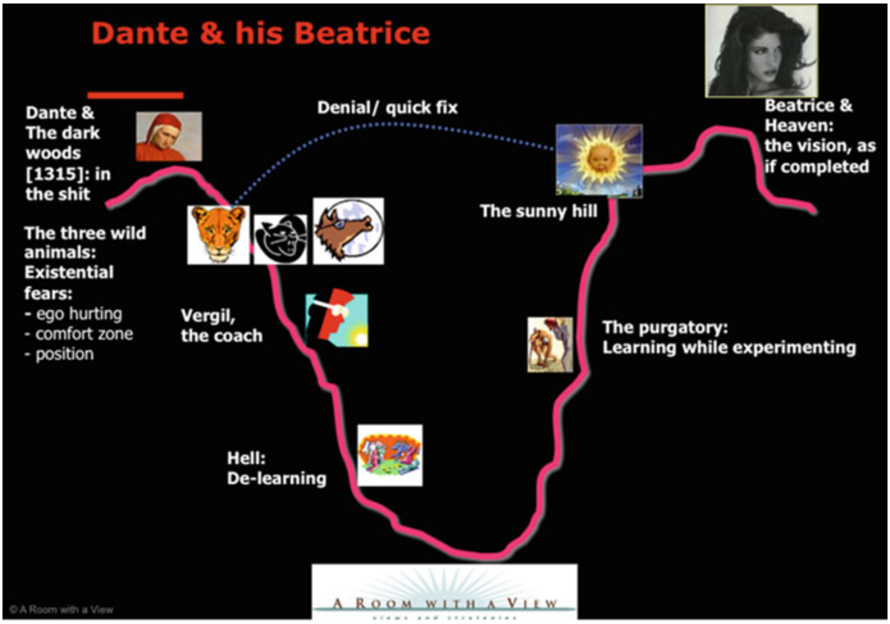

Fig. 4.6 Dantes Divina Commedia as metaphor for change management (Source: Vervoorn 2003)

The fluency of the line in Figs. 4.5 and 4.6 represents the fact that the system itself is not fundamentally changed. After the transition the same system has reached a new stable state of a higher quality.

4.2.3 A Slow Pace or Advanced Transition

In general a transition starts when some sense of urgency is felt. For example, in the peak-oil case the transition is starting to 'take-off' very slowly, due to the awareness of urgency amongst a large group of people. While oil reserves are shrinking rapidly at the same time, the question is whether the transition to a system functioning without oil can be completed before we run out of fossil resources: a disaster of leaving a large number of people without energy. The transition starts at the moment the *zone of urgency* (Fig. 4.7) is entered, but is only completed after the disaster has happened. Problem solved, but the disaster could not be prevented.

Two ways of alternative, more anticipative, transitions are distinguished: (I) an *advanced* and (II) a *slow-pace* transition (Fig. 4.7).

In order to prevent the disaster from happening an alternative transition pathway needs to be developed. The first alternative is to keep the pace of the transition the

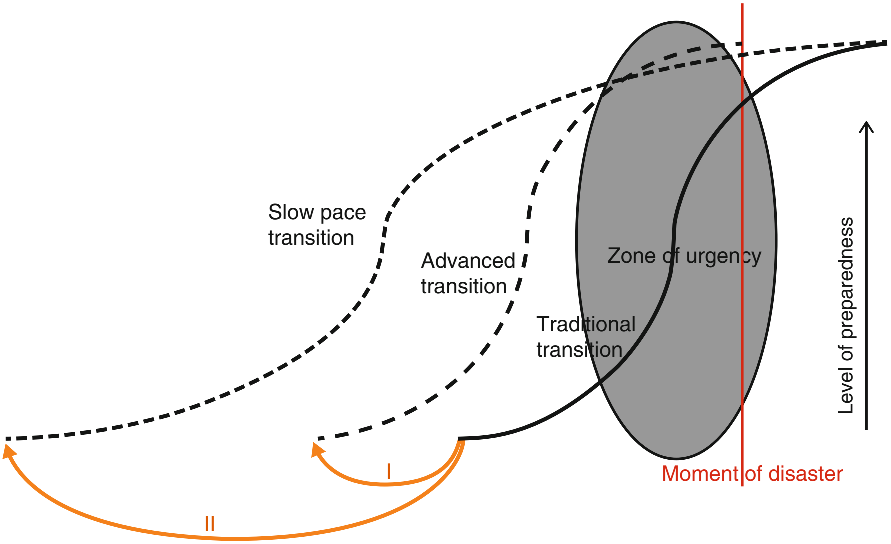

Fig. 4.7 Advanced (I) and Slow pace (II) transition

same, but begin the process earlier: an *Advanced* transition (I). The early start allows the transition to be completed sooner. Problem here is that required changes are needed in the same pace, but without a sense of urgency, which makes the reason for change unclear. Another alternative is found to start the transition-process earlier, but also 'down-pace' the speed of the transition: a *Slow-pace* transition (II). This makes it possible to implement small steps of change that are acceptable without the sense of urgency. Both pathways have their transition completed before entering the zone of urgency and ahead of the moment a disaster occurs.

4.3 Transformation

Transformation trajectories are the subject of a growing body of literature (Gunderson and Holling 2002; Geels and Kemp 2006; Chapin et al. 2010). Burgess defines transformation as "the ability to change to a new identity if the old one is not appropriate" (Burgess 2010). Folke and colleagues (2010) describe a transformation as "the capacity to transform the stability landscape itself in order to become a different kind of system, to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable". A "fundamental change in a social–ecological system results in different controls over system properties, new ways of making a living and often changes in scales of crucial feedbacks" (Chapin et al. 2009). Transformations can be purposefully navigated or happen unintended.

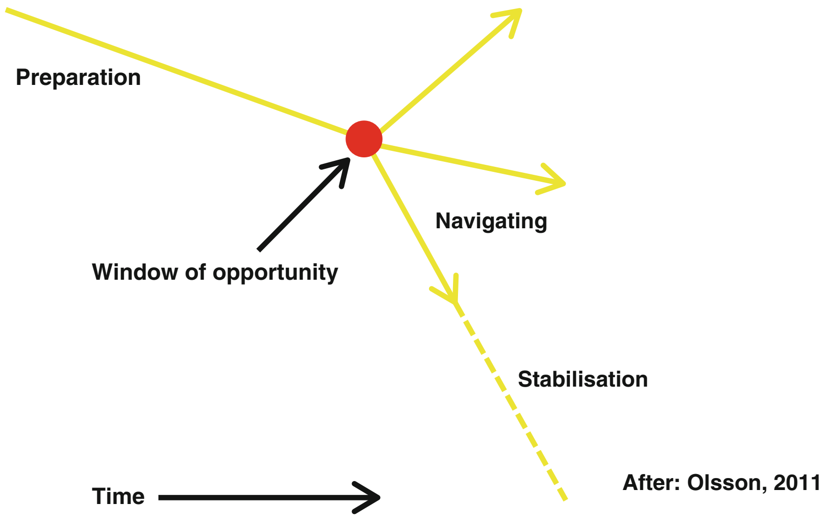

Fig. 4.8 Three phases of transformation (After: Olsson 2011)

In the works of Olsson and colleagues (2006) and Chapin and colleagues (2009), transformation is divided in three phases (Fig. 4.8): preparing, navigating and stabilising. The moment between preparing for and navigating a transformation is defined as the window of opportunity (Olsson et al. 2006). The property of a window of opportunity is "the presence of many options yet a short time-frame to start a transformation" (Olsson et al. 2006), the "occurrence of a crisis, which makes it possible to plan for a transformation" (Chapin et al. 2009) and a "set of activities pursed" (Olsson et al. 2006) "in a sequence of events leading to the start of navigating the transformation" (Olsson 2011).

Despite the fact that this process is called a transformation, it may be questioned whether this described change is (limited to) only a change of direction within one system, and making it better prepared for changed circumstances. Hence, it does not describe a transformation of the system into another system.

Blauwhof and Verbaan (2009), based on Perez (2002), argue that subsequent (and disconnected) 'waves' appear and that the 'next' wave has already started while the former is still ongoing (Fig. 4.9). The disconnected waves 'overlap' within a certain zone (A and B in Fig. 4.9), which operates as the window of opportunity, where navigation a transformation starts.

Ainsworth-Land defines "Growth as the single process (in nature) that forms the keystone of transformation theory and that unites the behaviour of all things". He distinguished three phases of growth: forming (Phase 1), norming (Phase 2) and integrating (Phase 3). These three phases together shape the transformation. In between successive growth cycles (the transformations) a stable, growthless, period occurs. This transition period is therefore represented through a flat line (Fig. 4.10). At a later stage he adjusted his theory and defined the transformation periods as overlapping growth cycles (Fig. 4.11). A new phase one (forming) starts already while phase three (integrating) of the previous cycle is still active (Ainsworth-Land 1986).

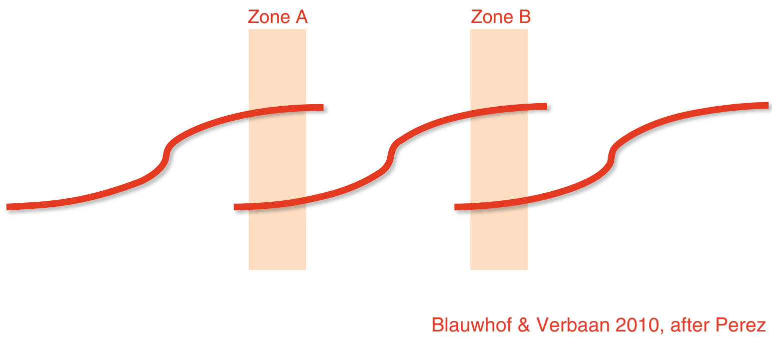

Fig. 4.9 Disconnected 'waves' (Source: Blauwhof and Verbaan)

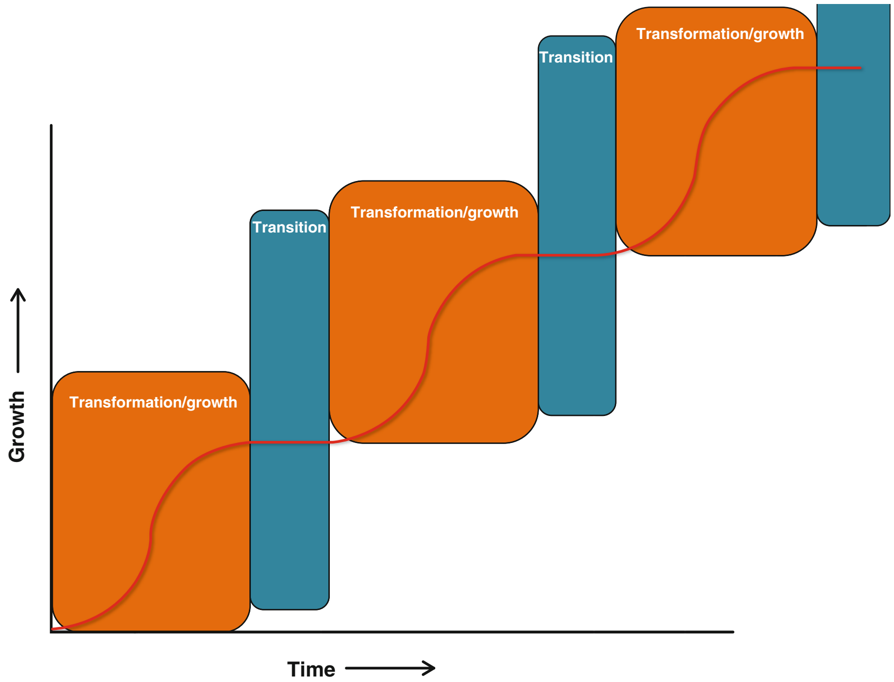

Fig. 4.10 Successive phases of growth (transformation) and transition (Adapted from: Ainsworth-Land 1986)

This new phase one interfering the existing growth cycle or regime originates through the development of niche innovations, one of the levels that are part of the multi-level perspective (Geels 2002, 2005, 2011). The multi-level perspective theorises non-linear processes resulting from an interplay of developments on three analytical levels: niches, (the locus of radical innovations), socio-technical regimes (the locus of established practices and associated rules that stabilise existing systems) and the

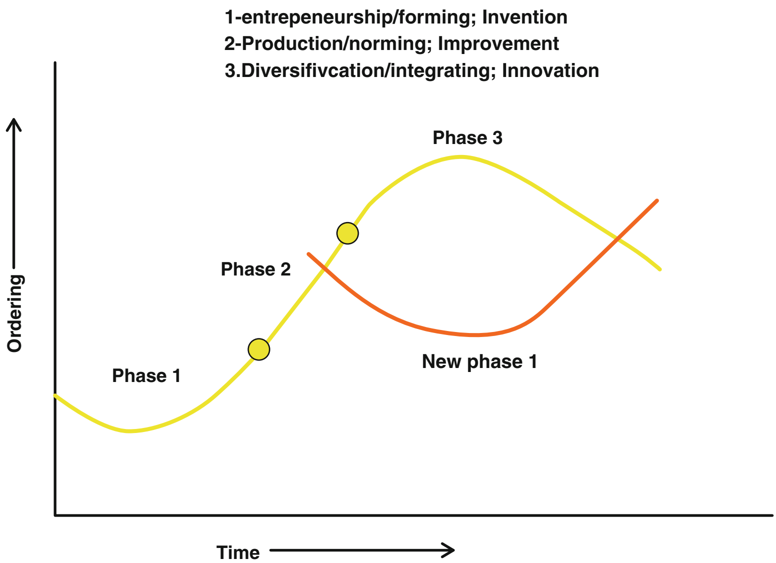

Fig. 4.11 Overlapping growth cycles (Ainsworth-Land 1986)

exogenous socio-technical landscape, representing the nearly unchangeable values and biophysical features of the system. The level of the socio-technical regime is the level that is stable and the level where change is effective on, because here the regime can shift from one to another. Change starts in niches or where novel configurations appear (Geels 2002). The effectiveness of the change e.g. weather a regime shift will occur depends on the alignment of developments. Successful processes within the niche are reinforced by changes at the regime and/or the landscape level (Kemp et al. 2001: 277). Hence, this reinforcement determines whether a novelty fails, modifies the regime or transforms the landscape (Fig. 4.12).

The process of change consists of several elements (Fig. 4.13). The existing regime is dynamically stable (point 2), which means that it is potentially open for change. However, it will only open up if the pressure from the landscape level creates a window of opportunity (point 1). Both levels then influence externally the niches (point 3, 4), which supports the development of novelties (point 5). Once these novelties are developed and are aligned towards a dominant design (point 6), they are capable of breaking through the existing regime (point 7) and enforce adjustments to the old regime, which then will transform into a new regime. Eventually, when the regime shifts are profound, they may influence the landscape level, changing the set of values and/or biophysical properties (point 8).

Elaborating on the former theories, the transformation of a system originates somewhere outside the existing regime or system while the system is still operating in its dynamically stable regime. The start of phase one (forming mode) of the growth curve of system B takes place where niche innovations are located, while system A (the stable regime) is still functioning in its integrating mode. The forming of system B only takes place through novelty development, disconnected from the

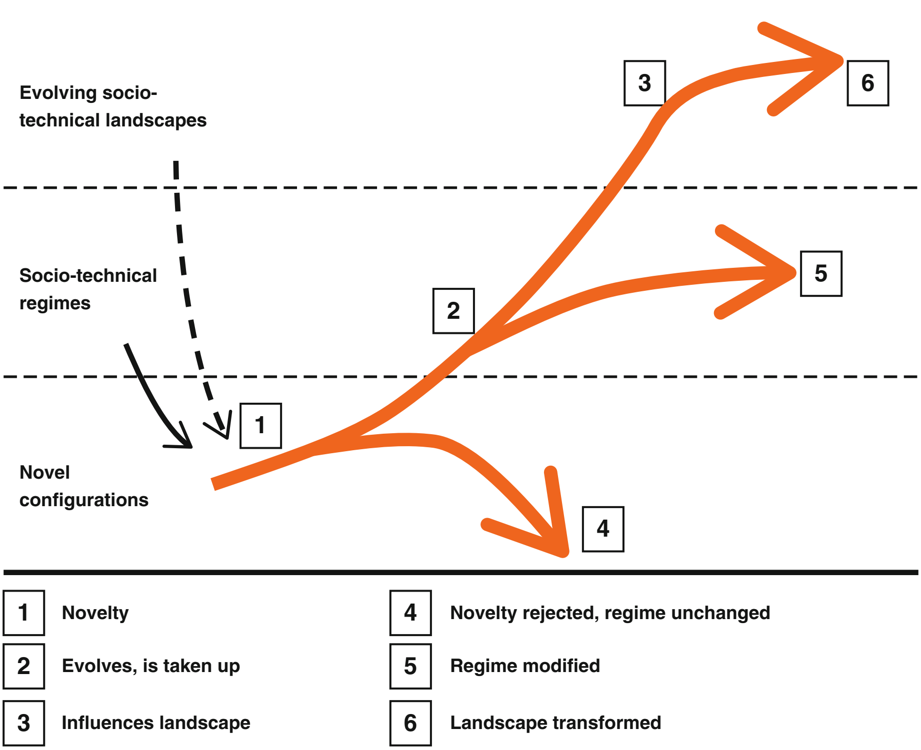

Fig. 4.12 Uptake of novelties (Adapted from Rip and Kemp 1996; Kemp et al. 2001; cited in: Geels 2002)

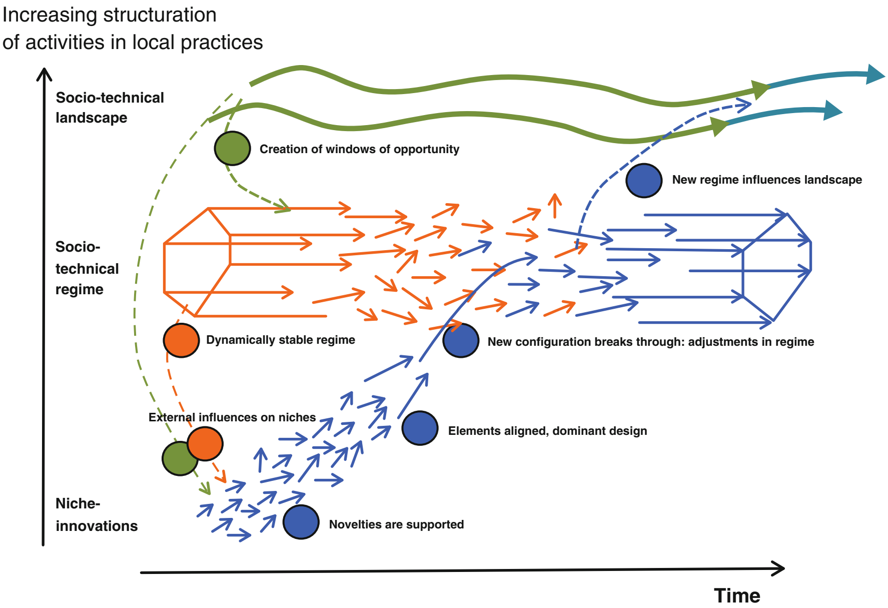

Fig. 4.13 Interaction between the levels of the multi-level perspective (Geels 2002, 2005, 2011)

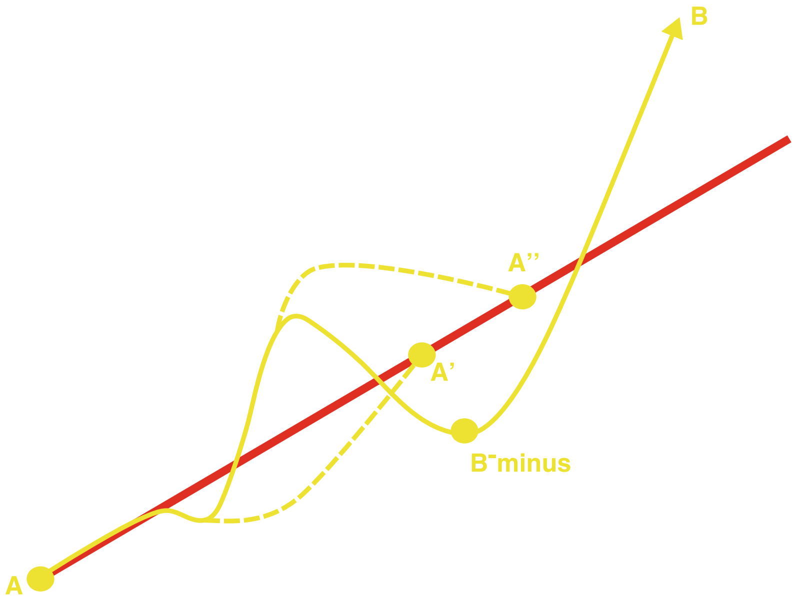

Fig. 4.14 The fluent line of transition changes A in A-**apostrophe**, while the shift to B requires a discontinuous process through B-**minus**

current stable regime. Whenever these novelty developments return to the stable regime and become part of the existing again, an adjusted system A has been created (e.g. *A-apostrophe* or *A-double apostrophe*, Fig. 4.14). System B, represented through the novelty developments, needs to follow its own growth curve of forming, whilst crossing system A, and overtaking it in its norming and integrating phases (Fig. 4.14). Here, we name the forming phase of B, *B-minus.*

In order to ignite the forming of system B the transformability, "the capacity to create a fundamental new system, when ecological, economical or social conditions make the existing system untenable" (Walker et al. 2004), of the system must be 'triggered' by a new and attractive vision on what this alternative system (B) has to offer. Only then the system will change pathways, transforming, and derails from the pathway of change (transition). Transition brings an existing system out of balance and into a new stable state of the same system, while a transformation transforms the system into a fundamentally new one: the transformation (growth) of B replaces system A. A resilience approach allows a new identity to emerge through interactions within and across scales, introducing new defining state variables and losing others (Folke et al. 2010). Transformations are announced through elements that represent the forming of system B, although they are invisible yet.

1. If fundamental shifts in socio-economic, technological and spatial systems are required a transformation is suitable;
2. Transformations describe a fundamental shift;
3. Both transitions as transformations can be used to define and achieve an attractive future (B) in the face of climate change. However, the change

implied through a transformation might be larger than through a transition might be reached.

A transformation process offers better prerequisites to deal with and achieve the fundamental change.

4.4 B-Minus

The concepts of transformation are elaborated and new concepts were developed during the so-called pizza debates; e.g. in small group sessions of (2–3) people the concept of transformation has been in depth discussed. Over a period of 6 months regularly meetings took place and an iterative process of consecutive 'brainstorm-capture-writing-brainstorm-elaboration-capture-writing' was organised. This has led to the description of the process of transformation, starting in B-minus.

Current spatial plans include changes that are too small to call it fundamental change. This is caused by the fact that during a period of stability and satisfaction existing paradigms continue to be adapted in political cycles. After a while, political cycles come to an end and allow for a shift to a fundamental new paradigm. The repetitive spatial plans are improved during this stable period, but they stay within the same type. A shift from A (the original) towards *A-apostrophe* and *A-double apostrophe* takes place, but B, a fundamental new type of spatial plan will never be achieved (Fig. 4.15).

Every transformation needs to start with framing the desired future (system B) in an attractive way that responds to a certain urgency. Elements such as icons, identity (Castells 1996), branding (Franzen and Bouwman 1999; Roberts 2006), branding identity (Ghodeswar 2008), and a stickiness factor (Gladwell 2000), all play an important role in making the future vision attractive. Moreover, dynamic planning has to be applied when an attractive climate adaptive future needs to be designed (Berger and Chambwera 2010). Only then, high expenses and existing standards can be overcome.

We distinguish two situations, in which a change of pathway towards is likely to occur.

1. A disaster can disturb the stable regime, represented as a regular, straight pathway of steps towards the future (Fig. 4.16). In case of a disaster regular policy will temporarily no longer be relevant, as immediate action is required. An instant a shift from one pathway to another is likely. Hardly visible to regular policy-making, pathway B was already in operation but suddenly becomes interesting, as it enables pathways to recover and provides solutions for the longer term (Fig. 4.17).
2. The current system slowly fades away, for instance because it does not meet current demands anymore. At a certain point another system takes over (Fig. 4.18), because the new system (B) contains the features the current timeframe demands.

The change from the current functioning system (A) towards a new system (B), induced by a disaster or a slow fade away (Fig. 4.19), takes place through the

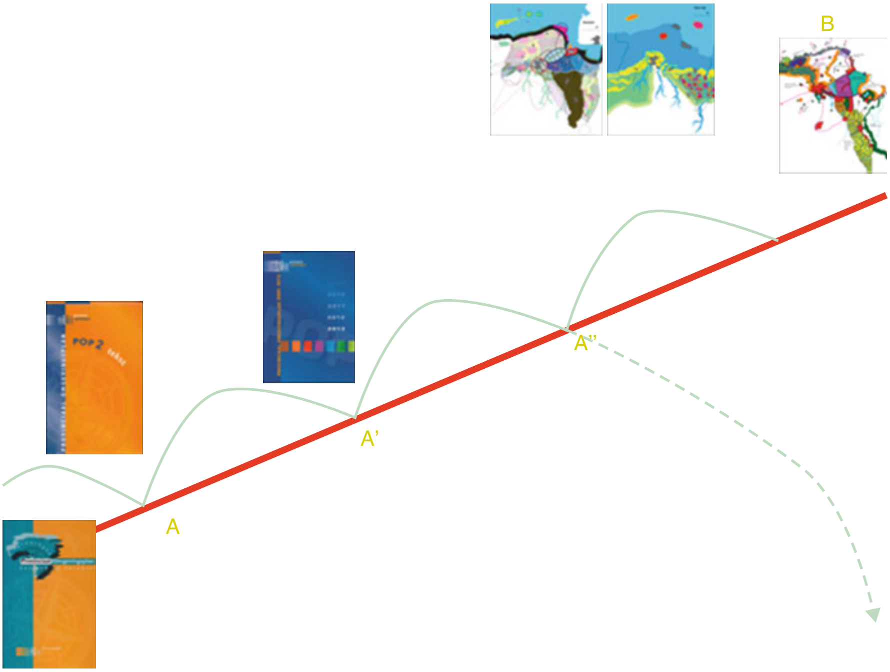

Fig. 4.15 The desired future system (B) is defined, but 'missed' by consecutive spatial plans

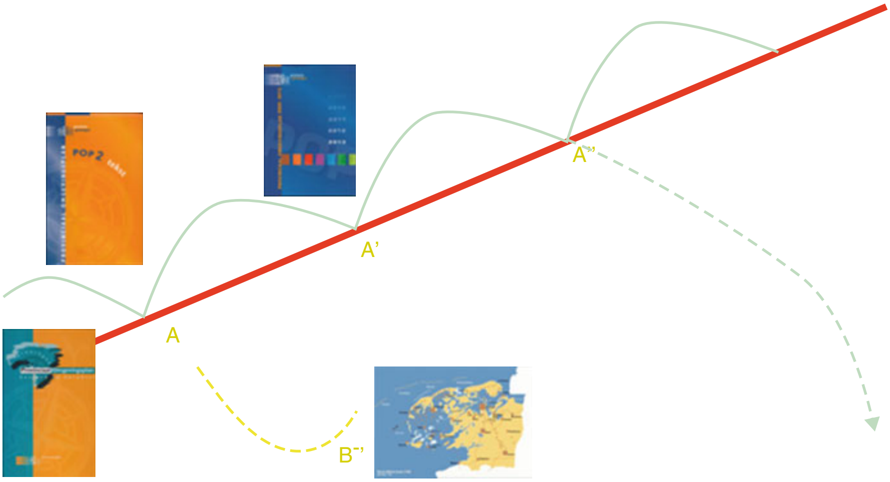

Fig. 4.16 A disaster enforces the move of system A off-track

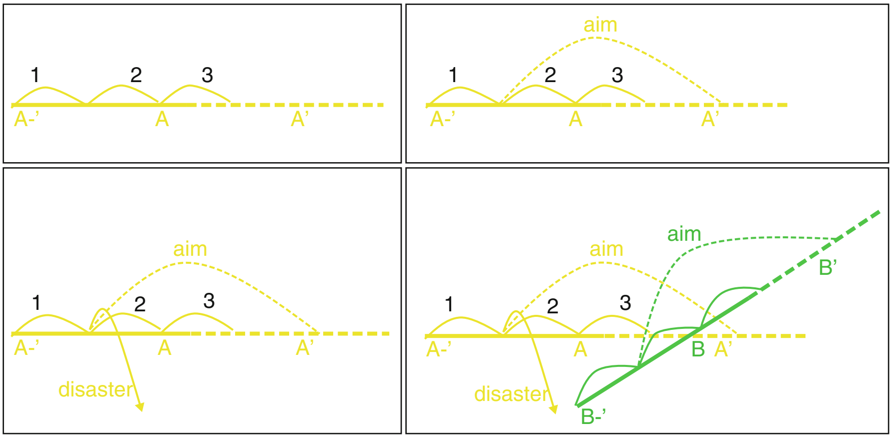

Fig. 4.17 After a disaster pathway B takes over

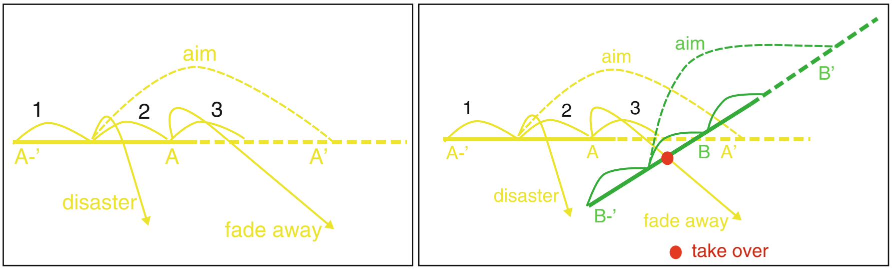

Fig. 4.18 System A fades away and B takes over

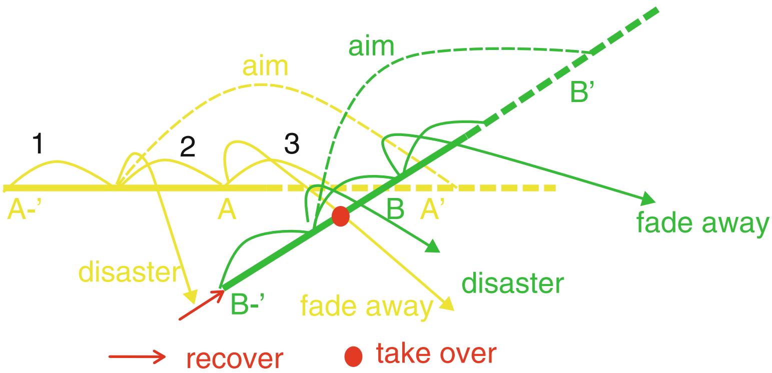

Fig. 4.19 Recovery and fade away in one image

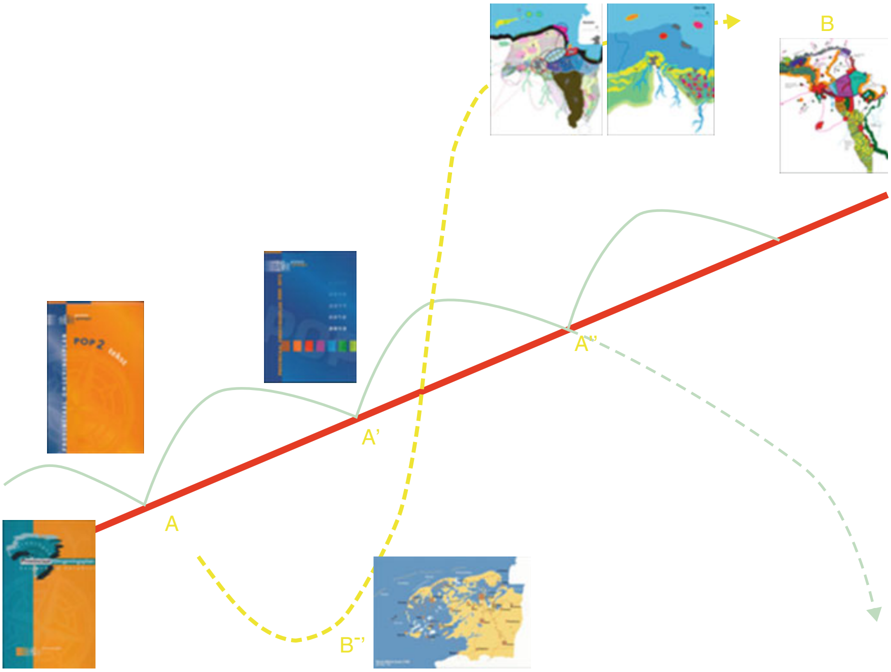

Fig. 4.20 Towards B via B-**minus**

pre-phase of B: '*B-minus*' (Fig. 4.20). This rudimentary stage (the *forming phase*, or the location of *niche innovations*) of the new system B contains elements of the new system, but is far from complete. In order to anticipate or stimulate a transformation it is important to recognise or create these predecessors of B. This will be discussed in the following chapter.

4.5 Early Signals

Once the attractive future system is defined, it is possible to search for the elements of *B-minus*, as these can be seen as a *backtracked* version of that future. In contrast with forecasting (predicting the future starting from present) or backcasting (define the desired future, and derive from that the steps to be taken to realise that future), backtracking goes back in history to find a sustainable equilibrium, which functions as an inspiration for defining a desired future system and from derive from that the steps to realise it (Fig. 4.21) (Schoot Uiterkamp et al. 2005).

The window of opportunity as defined by Olsson et al. (2006) is the key moment to start a transformation and also the moment when elements of the *B-minus* state become visible.

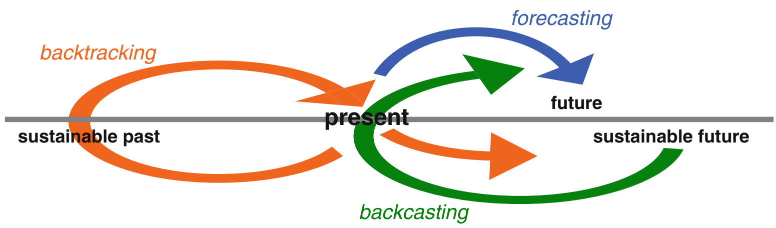

Fig. 4.21 The difference between forecasting, backcasting and backtracking (Van den Dobbelsteen et al. 2006)

The elements of *B-minus* can be determined in two ways:

1. Observation or active search for signals announcing a transformation, so-called early warning signals (Scheffer et al. 2009);
2. The active creation of harbingers of a transformation.

4.5.1 Early Warning Signals

In the work of Scheffer et al. (2009) early warning signals are defined for systems approaching a major change. Despite the fact that it is very difficult to develop accurate models to predict thresholds in most complex systems, Scheffer and colleagues discuss the generic character of early warning signals from a range of complex systems. They conclude: "if we have reasons to suspect the possibility of a critical transition, early-warning signals may be a significant step forward when it comes to judging whether the probability of such an event is increasing". They distinguish the following signals:

1. Critical slowing down: The intrinsic rates of change in the system decrease, leading to a system state that more and more resembles its past state. Two symptoms are distinguished: increase of autocorrelation and increase of variance.
2. Skewness: An unstable equilibrium, which marks the border of the basin of attraction, approaches the attractor from one side. In the vicinity of this unstable point the rates of change are lower. As a result, the system will tend to stay in the vicinity of the unstable point relatively longer.
3. Flickering: The system moves back and forth between the basins of attraction of two alternative attractors.
4. Types of spatial patterns: (1) scale-invariant distributions of patch sizes and increased spatial coherence, or (2) the appearance of regular patterns in systems governed by local disturbances.

These signals not necessarily contain a spatial dimension or make them easy to use or understand in a spatial planning context. However, in Table 4.1 a first attempt to 'translate' the early warning signals into possible spatial dimensions is presented.

Table 4.1 Translation of early warning signals into spatially relevant dimensions

Announcement of system change (early warning signals, derived from Scheffer et al. 2009)	Possible translation into spatial dimensions
Critical slowing down (increase of autocorrelation, increase of variance)	Maintaining old historic structures, re-emphasize existing patterns of functions
	Repetitive policies (the longer policies remain unchanged or are repeated over and over again, the closer we are to a system change)
Skewness	Dominance of one centre over another, core-periphery
Flickering	Temporarily repetitive occupation for living, temporarily repetitive flooding
1. Scale-invariant distributions of patch sizes/increased spatial coherence	Urban sprawl, repetitive urban patterns/ building blocks
2. Increase of regular patterns	

4.5.2 Creation of Starting Points for Change

Besides trying to identify early warning signals, another option is to actively create the starting-points for systems change. Points in networks where developments are likely to start can function as the elements of *B-minus*, places where the niche developments take place and capable of eventually leading us to the new desired system B. Network theory emphasises that some nodes in networks are more suited for the ignition of change than others. The following key characteristics of networks are derived from Newman et al. (2006):

1. *Enough Edges*: Once enough edges are added, properties of the network suddenly increase in quality (Erdós and Rényi 1960);
2. *The Core*: Directed networks consist of a core (a giant, strongly connected component), links-in and links-out, as well as other islands and tendrils, represented visually by Broder et al. (2000) as a bow-tie;
3. *High Level of Clustering*: The small world effect (Watts and Strogatz 1998) describes the characteristics of networks: if the number of nodes in the network increases, while connected by a short path, the total length of paths will increase logarithmically and a high level of clustering will occur. (Castells 1996);
4. *Fitness of Nodes* (Castells 1996): The increase of connectivity of nodes in a network depends on the fitness to compete for links (Bianconi and Barabási 2001). This fitter-gets-richer phenomenon helps to understand the evolution of competitive systems in nature and society;
5. *Connections*: Robust networks, at least complex biological ones, are formed by numerously connected nodes, which are highly clustered and know a minimum distance between any random pair (Solé et al. 2002).

Preliminary research, applying these principles to a concrete spatial situation (Hao and Wang 2010) made the theory useful for spatial planning. This research, in order to determine the points in the network with the greatest potential to start system change, analysed the networks in two ways: (1) the density of individual networks, such as the water- energy- or transport network, and (2) the number of different network types colliding at one physical location. The role of networks in identifying starting points for transformation is elaborated in Chap. 5.

4.6 Conclusion

As discussed in this chapter, current environmental problems require major system changes. In order to facilitate this, two approaches to describe and/or enhance change are investigated: transition and transformation. The main difference between the two is that transition aims to change the system to a better version and transformation emphasises a fundamental change into a new system. When major change is required transformation offers the most suitable way to not only describe the change, but also to stimulate it. Ainsworth-Land describes transformation in terms of growth and acknowledges that the growth of the 'next system' already starts while the current system still flourishes. Geels underpins this through locating the development of novelties separate from the existing stable regime. In this chapter these theories are elaborated, aiming to find the (transformation) pathway to reach this 'next system' (also referred to as system B).

As stated before, the transition of system A leads to a better version of the same system A: *A-apostrophe.* A transformation pathway, leading to fundamentally different (more resilient) system (B) needs to identify the elements that belong to this 'new system'. This transformation therefore starts in *B-minus*, the first (forming) phase of the new system, where the 'preliminary' parts of system B are found.

To determine *B-minus*, two ways are distinguished: through 'discovery' or as 'creation'.

Scheffer and colleagues theorise that early warning systems can be discovered, announcing the approach of a threshold and system change. These early warning signals are found in several types of systems, with exception of spatial systems. The first attempt to define these signals in spatial dimensions is presented in this chapter.

The other way to find *B-minus* elements is to identify the locations where those elements that get system change started are likely to be developed. Learning from network theory, the most dense nodes and the most connected networks are the most likely places.

In comparison, the pathways leading to *A-apostrophe* and B respectively (Table 4.2) have fundamental different properties. The A-apostrophe pathway is useful to enforce change if tame problems in relatively steady environments are to be dealt with. In this case linear thinking and a transition pathway can be used. However, wicked problem in a complex environment benefit from transformational change and non-linear thinking.

Table 4.2 Characteristics of pathways leading to respectively A-apostrophe and B-minus

A-apostrophe	B-minus
Tame problems	Wicked problems
Moderate environments	Turbulent environments
Transition	Transformation
Linear thinking	Non-linear (dynamic) thinking

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