

# Dealing with prognostic uncertainty

Citation for published version (APA):

van Asselt, M. B. A., Mesman, J., & van 't Klooster, S. A. (2007). Dealing with prognostic uncertainty. *Futures*, 39(6), 669-684. <https://doi.org/10.1016/j.futures.2006.11.011>

## Document status and date:

Published: 01/01/2007

## DOI:

[10.1016/j.futures.2006.11.011](https://doi.org/10.1016/j.futures.2006.11.011)

## Document Version:

Publisher's PDF, also known as Version of record

## Document license:

Taverne

## Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

## General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

[www.umlib.nl/taverne-license](http://www.umlib.nl/taverne-license)

## Take down policy

If you believe that this document breaches copyright please contact us at:

[repository@maastrichtuniversity.nl](mailto:repository@maastrichtuniversity.nl)

providing details and we will investigate your claim.

# Dealing with prognostic uncertainty

Marjolein B.A. van Asselt\*, Jessica Mesman,  
Susan A. van't Klooster<sup>1</sup>

*Department of Technology and Society Studies, Faculty of Arts and Social Sciences, Maastricht University,  
P.O. Box 616, 6200 MD Maastricht, The Netherlands*

Available online 11 January 2007

---

## Abstract

How do professional futurists contend with prognostic uncertainty? There is an impressive body of medical–sociological research on how medical staff deals with uncertainty. We have used these insights to study patterns and manners in foresight practice that might not be evident otherwise. The question “Do professional futurists use approaches to deal with uncertainty that resemble those of medical staff?” is addressed by ongoing ethnographic research in Dutch foresight practice. The observed manners are grouped into four analytic categories: the construction of solidity, numeric discourse, communication habits and experience as anchor. In this paper, the construction of solidity and experience as anchor are described in detail. It is further more suggested that “certification” is a possible upshot of these manners in use.

© 2006 Elsevier Ltd. All rights reserved.

---

## 1. Introduction

Foresight<sup>2</sup> implies dealing with prognostic uncertainty. In this article, the notion “prognostic uncertainty” refers to instances in which professional futurists have doubts about something in the future, partly or fully because (scientific) knowledge is perceived as absent, incomplete, irrelevant, insufficient, inaccurate, ambiguous, equivocal, inconsistent,

---

\*Corresponding author. Tel.: +31 43 3884790; fax: +31 433884869.

E-mail addresses: [marjolein.vanasselt@tss.unimaas.nl](mailto:marjolein.vanasselt@tss.unimaas.nl) (M.B.A. van Asselt), [j.mesman@tss.unimaas.nl](mailto:j.mesman@tss.unimaas.nl) (J. Mesman), [susan.van.t.klooster@ivm.vu.nl](mailto:susan.van.t.klooster@ivm.vu.nl) (S.A. van't Klooster).

<sup>1</sup>Now at the Institute for Environmental Studies (IVM), Vrije Universiteit, Amsterdam, The Netherlands.

<sup>2</sup>There is quite some terminological confusion on how to characterize activities in which the future is the object of study (compare [1]). In this paper, we use the notions foresight and futures studies interchangeably.

fragmented, manipulated, complex or otherwise limited (compare [2]). See, for example, Fontela's sigh [3]:

We know little about the past and present in a multidisciplinary way. We know that sociological and political factors influence economic factors and vice versa. We know that technological developments lead to innovation that modify productive structures; we know indeed that the facts that determine change are many and that our scientific knowledge of the processes of change is clearly insufficient to forecast but even to explore [the future].

The acknowledgement of prognostic uncertainty is a common place in the scholarly futures studies community. Nowadays, scholars in the field of foresight routinely refer to uncertainty, or even increased uncertainty, as intrinsic to the future [4–12]. A futurist is often portrayed as an “analyst (...) dealing with the unknown (and to some degree unknowable) future” [13]. The intriguing question is how do futurists deal with prognostic uncertainty in actual foresight endeavours?

Wilkinson and Eidinow [8] argue that most people's response to prognostic uncertainty is to take refuge in what they already understand about the world: “And, all too frequently, this remains limited to familiar ideas based on past experiences or current fashions”. This resort to familiarity and “certainty” seems a reflex in western societies [14,15]. The question is whether and how futurists manage to respond differently. That is not just an important issue for the futures studies field. Uncertainty is perceived as a hallmark of our era [16]. As Funtowicz and Ravetz [17] and Morgan and Henrion [18] emphasized, dealing with uncertainty is not a straightforward endeavour, as it challenges the classical positivist paradigm (see also [19–22]). Both Schön [23] and Nowotny et al. [16] suggest that clues may be discovered from studying uncertainty manners in use. Insight into how futurists deal with prognostic uncertainty is of general importance. However, in the edited volume “Contested Futures” [24], it is argued that handling of prognostic uncertainty in foresight is an “at present taken-for-granted and disattended social process”. It is surprising how little critical and systematic attention is paid to dealing with uncertainty in the practice of foresight in view of the restated portrayal of futures studies as the art of understanding or even managing uncertainty (see, for example, [5–7,25]). Brown et al. [24] suggest that empirical social scientific research has an important role to play in rendering visible how prognostic uncertainty is actually dealt with. In this paper, we report such empirical research on the ways in which professional futurists deal with prognostic uncertainty.

Our aim is thus *not* to contribute to methodological–epistemological discussions in the scholarly literature on how futures studies *should* be done.<sup>3</sup> We attend to how foresight *is* done and we direct our attention to how particular practitioners deal with uncertainty in foresight endeavours. We would like to disclose practical uncertainty manners that usually become concealed or overlooked in self-accounts and methodological–epistemological discussions. We want to understand the detailed activities futurists perform in dealing with uncertainty. For this type of interest in actual practice, it is advocated to study practitioners while they are doing their work ([32,33]). Such *in situ* monitoring or “participant observation” is generally referred to as

<sup>3</sup>Well-referenced contributions on methodology–epistemology of futures studies include [26–31] and the Slaughter 1984 article series “Towards a critical futurism” (World Future Society Bulletin).

ethnography (see [34] for a well-referenced introduction). Ethnography involves close attention, with some exactness, to the daily doings, deliberations and social processes in action [35].

In the period 2001–2005, we<sup>4</sup> did ethnographic research among practitioners involved in actual foresight endeavours in the Netherlands. We talked to them and asked questions, both informally and in arranged open interview settings. We made notes on what we saw happening, on what we saw futurists doing and on what we heard them say, including non-verbal behaviour and monitored phone calls or bilateral chats. We collected documents that featured in the futurists' activities or that the futurists produced. We retrieved and received e-mails, we took pictures, we audio recorded many meetings and transcribed the tapes. We shared some observations with the futurists and recorded their feedback. After an introduction into Dutch foresight practice, we report our insights on dealing with prognostic uncertainty gained through this ethnographic research.<sup>5</sup> Finally, in our conclusions we will sketch a possible outcome of the observed manners in use.

## 2. An introduction to Dutch foresight practice

Since the 1970s and 1980s the assessment of the future has become increasingly popular in Dutch policy arenas [39,40]. In the course of time, it has become the arrangement that planning agencies, such as the economic planning agency (centraal planbureau (CPB)), the environmental and health planning agency (rijksinstituut voor volksgezondheid en milieu (RIVM), recently renamed: milieu en natuur planbureau (MNP)) and the spatial planning agency (ruimtelijk planbureau (RPB)), and institutes as the scientific council for governmental policy (wetenschappelijke raad voor regeringsbeleid (WRR)) and the energy research centre (energieonderzoek centrum nederland (ECN)), assess the future on behalf of the Dutch government. The field sites of the ethnographic research comprised RIVM, RPB and ECN, as well as CPB, as the latter institute also participated in a collaborative foresight endeavour with RIVM and RPB.

It seems legitimate to speak of “an institutionalized governmental system for the assessment of the Dutch future” [41]. Also Hollinshead [42] refers to the Dutch foresight practice as “part of the official planning apparatus”. The assessments of the future produced by the planning agencies are generally considered authoritative. Dutch policy-makers seem to take these assessments very seriously. Routinely, these outlooks, with the CPB assessments as the most prominent, are referenced in strategic policy documents and political discussions. Futures studies are often covered in Dutch newspaper articles, sometimes even as front page news. The American sociologist James Kennedy<sup>6</sup> specialized in Dutch culture even suggests that “ingrained teleology” and the development of long-term visions of the future are distinctive features of Dutch society. A recent, but incomplete, inventory ([43], see also [www.toekomstverkenning.nl](http://www.toekomstverkenning.nl)) contains over 150 Dutch

<sup>4</sup>The “we” in this paper needs some clarification. The ethnographic research in foresight practice has been carried out by Marjolein van Asselt and Susan van 't Klooster. So in case “we” is used in the context of the observations among futurists it actually refers to two of the three authors. However, for reasons of readability we, the three of us, decided to explain that only once in this footnote.

<sup>5</sup>For other publications see [36–38].

<sup>6</sup>In an article in the Dutch newspaper NRC Handelsblad (November 13, 2003).

futures studies since 1997. It seems no exaggeration to argue that by all measures the future is big business in the Netherlands.

Also in Dutch foresight practice, the uncertainty of the future and prognostic uncertainty in futurists' accounts are routinely acknowledged. For example, the Dutch WRR, a governmental agency that pioneered in the field of future studies, stated in their retrospective that "future studies are primarily about uncertainties" [44]. In the 5th Environmental Outlook [45], it is explicitly argued that "the future is uncertain" and that "[t]he processes described (...) in this (...) outlook are interlarded with uncertainties". Also Dobbinga [46] reports prognostic uncertainty as an explicit point of departure in a scenario project at the Dutch Ministry of Transport. In almost every work session we attended on the shop floor, we came across comparable references. We heard, for example, futurists talking about "many uncertainties" and "the uncertainties the future offers us", qualifying particular statements about the future as "highly uncertain" as well as arguing "the further into the future, the more uncertain it gets" and "it is very uncertain, but we have to say something". In the good tradition of futures studies, Dutch futurists argue that "notwithstanding uncertainty" "we can attempt to build a systematic outlook of [the] future" [47]. However, their methodological self-accounts, if available, usually hide how prognostic uncertainty is dealt with.

We think that the Dutch practice is an interesting case of futures studies and an appropriate site to study uncertainty manners in use. Having said that, in contrast to for example [4], we do not want to approach our case as "best practice". Neither do we use our empirical research as a basis to propose institutional frameworks of foresight, which is the way in which other authors used case-studies [48–50]. That would be far too pretentious. So, we do not claim Dutch practice is representative for the "state-of-the-art", but at the same time we dare to argue that it also not peculiar: the Dutch Environmental Outlook has been a model for European environmental outlooks, Dutch futurists participate in international foresight endeavours, such as IPCC endeavours and the scope of many Dutch assessments (such as energy foresights) is increasingly European. Furthermore, the futurists explicitly relate to and use international endeavours, reports are often available in English to allow review and they are cited outside the Netherlands. Benefiting from earlier review work [52–55] and our practical experience in international foresight endeavours (e.g., [56–58]), we tried to select observations that seem salient and illustrative in an international perspective. We do agree that the need for sharing of practical experiences exist [4] and that the development of futures methodology is an ongoing process [51]. With our ethnographic study of a particular practice of foresight, we hope to advance reflection, which in turn may contribute to further development of the field of futures studies.

Schön [23] breaks a lance for reflection-in-action, i.e. practitioners' own thinking about what they are doing: on tacit norms, on strategies and theories implicit in behaviour, on problem framing, etc. Such reflection enables practitioners to surface and criticize tacit understandings, make new senses and develop new approaches. Schön [23] suggests that researchers studying professional activity should help practitioners to reflect instead of maintaining a superior distance. In this vein, the aspiration is that our reflection-on-action account will help futurists—in the Netherlands and elsewhere—to understand and recognize the complexities of their endeavour and we aim to provide insights that they can benefit from.

Table 1  
Main salient differences between NICU and foresight practices

	NICU	Professional futurists
Assignment	Assess and act	Assess
Aggregation level	Micro	Macro
Temporal room	Short	Long
Type of practice	Micro-cosmos	Boundary work

### 3. Research approach

Futurists are not the only professionals challenged to deal with prognostic uncertainty. Also medical staff is confronted with it and has to find ways to deal with it, see, for example, Mesman's ethnographic study of neonatal intensive care<sup>7</sup> practices [59–61]. This research is another step in medical–sociological research on uncertainty in medical practice that started with Fox's seminal *Training for Uncertainty* [62–69]. Of course, there are obvious differences between medical staff at neonatal intensive care units and professional futurists (Table 1). The *assignments* differ. In the medical case, staff has to act based upon their own assessment of the future, while the professional futurists' task is usually bounded to assessment, which are supposed to inform decision-makers. Another difference is the *level of aggregation*. In the medical practices, everything revolves around specific individuals. The outlooks produced by professional futurists are primarily about major issues and macro developments. It may even happen that the ultimate outlook is portrayed as a product of an institute, rendering individual futurists anonymous. Also the *temporal space* available to assess the future differs. In medical practice the time available may be a question of less than an hour, while empirical research on Dutch foresight in the public sector (see, also [46] and [39]) indicate that such futures studies usually take 1–1.5 years or more. Also the *type of practice* is quite different. A NICU is both literally and metaphorically a highly protected environment where access is restricted. In the foresight case, professional futurists in the public sector coordinate between the policy realm and the realm of knowledge and expertise. Therefore, Halfman and Hoppe [70] explicitly characterize the activities of Dutch agencies involved in foresight as “boundary work”, a notion coined by Gieryn ([71,72], see also [73]).

Notwithstanding these differences, practitioners in both practices have to assess uncertain futures as a basis for acting or decision-making in the present or the near future. We have asked ourselves whether insight into how medical staff deals with prognostic uncertainty may help to observe and understand how professional futurists contend with prognostic uncertainty. So we did not do a classical comparative study, in the sense of a key-parameter design which seeks to systematically compare and contrast differences and similarities along dimensions that seem theoretically fruitful. We have mobilized the insights gained on medical practice as a search light<sup>8</sup> to *see* manners practiced

<sup>7</sup>Neonatal intensive care units (NICU) specialize in the care and treatment of newborns, which are seriously at risk in view of prematurity, complications at birth, congenital diseases or potentially lethal infections. The unfolding of newborns' immediate and longer-term future are usually all but predictable, even for experienced staff.

<sup>8</sup>A notion borrowed from [73].

by professional futurists, which is a more ethnographic approach to comparison. In such a vein, comparison has the value of revealing patterns that might not otherwise be evident [74].

#### 4. Uncertainty manners in use

The question “Do professional futurists use approaches to contend with uncertainty that resemble those of intensive care staff?” provided the starting point for examining manners in use in foresight practice. We have grouped the observed uncertainty manners into four analytic categories, i.e.

- *Construction of solidity*: particular prognostic uncertainties are transformed into firm building blocks.
- *Experience as anchor*: deploying historical evidence and acquired know-how to interpret uncertainty.
- *Numeric discourse*: the certainty connotation of numbers and numeric models is mobilized in diverse ways.
- *Communication habits*: vagueness and postponing, with camouflage and delegation of uncertainty as possible social outcomes.

In the current paper, we will detail the construction of solidity and experience as anchor. We briefly discuss the manners as practiced in intensive care practice, and then describe in more detail similar or comparable ways of dealing with prognostic uncertainty observed among Dutch futurists.

##### 4.1. *The construction of solidity*

###### 4.1.1. *Real risks and safe uncertainties*

Mesman [59] showed that in medical practice, solidity is created through particular trading with medical uncertainties. Risks differ in their level of attributed probability: it is always uncertain if complications will indeed occur. One way medical staff deals with prognostic uncertainty in practice is to ignore the probability and to act as if a specific risk will in fact become a reality.

Contrary to the medical staff, the professional futurists do not act themselves. Nevertheless, examples of treating risk as a reality as way to deal with prognostic uncertainty can be found in futurists' advices for policy-makers. In the 5th Environmental Outlook [45], it is, for example, argued that new technologies, now thought of as “solutions” for persistent environmental problems, may create new problems in the next 30 years. Like in the medical case, the possibility is then transformed into the assumption that it will happen, which is then the basis for further assessment. The result is an unconditional recommendation on particular strategies.

Interestingly enough, this manner of dealing with prognostic uncertainty has more effects. By trading particular uncertainties as risks, some other uncertainties are, explicitly or implicitly, qualified as harmless or irrelevant, and thus waved aside. Solidity is created here both by transforming some prognostic uncertainties into real risks and the accompanying disregarding of “safe uncertainties”.

#### 4.1.2. Policy as building block

Next to the above mechanism, our observations yield that futurists also use policy-makers' agreements as building block in constructing solidity.<sup>9</sup> In this way, they manage to disarm particular prognostic uncertainties as is nicely illustrated by the following exchange between some futurists:

- J. The health effects and the effects on ecosystems, we don't know them very well. The uncertainties there are much larger than earlier in the chain.
- F. And that is extraordinary alarming (..).
- K. But that is also very not worrisome, because it is so alarming. In Europe we have said (..) we call it a norm (..).
- F. You hide behind the norm.
- K. Indeed, but that is practical.
- F. Yes but it doesn't solve the problem.
- K. Well, but we have got rid of that very large uncertainty.

Norms set by policy-makers are treated here as realities, in quite a same way as medical staff treat risks as realities.

#### 4.1.3. Perspectives

The medical case also reveals that in dealing with prognostic uncertainty often another choice is generated: the choice between one risk (such as a bleeding) and another risk (such as an infection). In such situations, uncertainty is dealt with through the choice of the type of risk, practitioners are willing to take. Douglas [76–78] and others have convincingly shown that different “risk cultures” exist. The consequence is that people differ in the willingness to take a particular risk. Mesman [59,61] emphasized that such a priori attitudes serve as a compass for medical staff. It enables them to choose between different types of risks and to act accordingly.

It seems that risk perspectives also matter in foresight practice. In the course of a foresight endeavour, 18 professional futurists gathered in a workshop. The participants were clustered in three break-out groups according to three risk perspectives:<sup>10</sup>

- For *individualists*, changes in principle provide opportunities for human ingenuity that will be revealed through market mechanisms. This perspective can be characterized as risk seeking.
- *Hierarchists* view the role of management as careful control in order to keep the system within its limits. This perspective is associated with a risk-accepting attitude.
- The *egalitarian perspective* is concerned about the vulnerability of nature. It advances an eco-centric and environmental risk-averse attitude.

The futurists themselves concluded that depending on the perspective different uncertainties are recognized and highlighted, while others are neglected in the foresight endeavour. They agreed that their own practice could be characterized as hierarchist.

<sup>9</sup>Compare van der Sluijs [75], who details how climate modellers use agreements about particular parameters as building blocks in their anchoring amidst uncertainty.

<sup>10</sup>These perspectives have been taken from Cultural Theory [78–81]. See also [56,82–89] who used these perspectives as starting point for model-based scenario analysis.



Analysis of the workshop output [21] yields that a hierarchist style of futures studies tends to neglect instabilities and shocks, and to disregard “new risks”, such as those associated with new artefacts or processes as genetic modification.

Our observations yield that futurists employ different ways to construct solidity as a response to prognostic uncertainty. They may transform particular prognostic uncertainties into risk and treat those risks as realities, while disarming “safe uncertainties”. Or they may advance norms set by policy-makers as realities. Furthermore, different risk perspectives yield a compass that enable futurists to decide which uncertainties to pay attention to.<sup>11</sup>

## 4.2. *Experience as anchor*

### 4.2.1. *Typical exemplars*

Mesman [59,61] describes how medical staff relies on experience in dealing with prognostic uncertainty. So-called “typical exemplars”, i.e. children in situations which are considered comparable in one way or another, are explicit references to experience. Typical exemplars can be experiences described in the scientific literature or the life-stories of previous patients, which the staff uses to draw conclusions about the future of the child:

I am afraid we are generating a second Mick. Ultimately, we also failed to get him off the respirator.

Staff members can also counterargument pessimistic prognoses with references to that extraordinary child who survived against all expectations.

We observed that professional futurists also have a repertoire of typical exemplars. They use historical events and processes, experiences in other countries, and particular events or developments qualified as anomalous although they did occur. Interestingly enough, also statements about the future in previous futures studies seem to serve as typical exemplars. But they also involve personal experiences. We witnessed that in discussing future possibilities in work arrangements, futurists employed a colleague as well as friends as typical exemplars. Also, their own building was mobilized to think about future energy-efficient possibilities and previous work experience in a home for elderly was invoked in thinking about the consequences of ageing.

### 4.2.2. *Temporal repertoires*

Inspired by Kosseleck [91], Mesman [59] argued that in medical practice two temporal repertoires are used in order to mobilize typical exemplars as foresight device. One is nicely captured in a nurse’s claim: “it went this way then, and so will it go now”. We characterize this repertoire as “historic deterministic”.<sup>12</sup> In the second repertoire, the future is not dictated by the past. History may repeat itself, but it not necessarily will. The future bears the promise of improvement. The past and present provide possibilities. We refer to this

<sup>11</sup>O’Connor et al. [90] claim on the basis of survey research that risk perceptions determine whether managers use long-term assessments: “Feeling at risk (..) stimulates a decision to use (..) forecasts”. This would imply that risk perspectives not only matter in dealing with prognostic uncertainty in the practice of producing foresights, but also in use contexts.

<sup>12</sup>Kosseleck [91] and Mesman [59] use the notion “cyclical” for this repertoire.

repertoire as “futuristic difference”.<sup>13</sup> Due to the existence of different temporal repertoires, the same typical exemplar may yield different assessments of the future. In the first repertoire Mick is the typical example of a child that emphasizes the futility of further treatment. In the second repertoire, the historic case of Mick contributes to optimistic expectations of futures of current children.

Our ethnographic research in various Dutch foresight endeavours yields that different temporal repertoires are used in the futures studies’ community.<sup>14</sup> The historic deterministic repertoire corresponds to the forecast tradition, in which the assessment of the long term involves extrapolation of trends and/or modelling of processes as they took place in the past. Extrapolative approaches are still in use. However, only a minority of the Dutch futurists is willing to defend the historic deterministic line of reasoning out in the open, and Dutch futurists easily disqualify futures studies done by other futurists as mere trend extrapolations. In doing so, futurists seem to dismiss the historic deterministic repertoire.

The idea of scenario analysis can be associated with the futuristic difference temporal repertoire. It fits with this way of thinking that different futures are possible and should be explored. This style of foresight is often explicitly motivated with reference to prognostic uncertainty. See, for example, the following claim in a Dutch foresight report: “As the long-term future is too uncertain, one single image of the future doesn’t suffice” [93]. Futurists employing the futuristic difference repertoire consider the notion of “prediction” “taboo” and claim that their reports “are screened for that” (interview quotes). The majority of current Dutch planning agencies’ foresights include two or more scenarios. So the futuristic difference repertoire appears to dominate and the historic deterministic repertoire is reviled, at least in futurists’ discourse.

In practice, however, the situation with regard to temporal repertoires is actually much more subtle and complex, as is illustrated by the following scene from a representative meeting of futurists involved in a multi-agency futures study. One of the futurists (E) is consistently advancing the historic deterministic repertoire, which is clear from utterances as: “The only thing you can look at, you can look to historic trends, (..) what has happened in the last 30 years”, and he literally states that “the historical trends should be a yardstick” in the foresight endeavour. He disqualifies proposed scenarios that violate historic trends as “unrealistic”, “not defensible”, “not plausible” and as “a completely new reality”. Another colleague (S) openly concludes about E: “Your belief in assumptions is strongly grounded in the conviction that you have to look back over the past 30–40 years”. M explicitly describes E’s attitude as “trend prognosis” and he emphasizes “we know that that is not what we want”. Also other futurists reject E’s historic deterministic stance. B, for example, states “we can discuss the degree and the pace [of change] but there will be scenarios that counter historic trends”. He openly disagrees with E: “No. Why would new circumstances always fit with current trends?” and “Who tells me that that will be the case in the future?”. Another objection is clear from S’s contribution: “last time, (..) we agreed that [a particular scenario] would not match the trend”. And R brings to the

<sup>13</sup>For this repertoire, Kosseleck [91] and Mesman [59] advance the notion “linear”.

<sup>14</sup>See [92] for a detailed analysis of temporal repertoires and the effects of coexistence of different repertoires in foresight practice. Van ‘t Klooster describes how coexistence of the historic deterministic and the futuristic difference repertoires may fringe in foresight practice to such an extent that it undermines key ambitions associated with scenario analysis.

fore “we have to realize that we are talking about a period as long as 40 years, in such a time frame a lot can change”.

Of the eight futurists in the room, E is the only pure historic deterministic advocate. However, although the other futurists oppose his point of view, at the same time historic deterministic arguments are part of their own frame of reference. When S asks P whether he thinks a particular idea is realistic, P responds: “Historically, it isn’t”. And M. claims that “the further you go away from the average trend (...) the less realistic it gets”. In a discussion about a particular choice in one of the scenarios, B argues in favour of that choice: “that is very pragmatic, but we should have it, because that is the trend”. And S openly admits: “I don’t get it (...) to what extent should the past set the scenarios?”. So futurists opposing the historic deterministic repertoire do also occasionally or even regularly employ historic deterministic arguments in face of prognostic uncertainty. Although in the futurists’ discourse the futuristic difference repertoire dominates, in practice the futurists struggle with how to use the past as anchor in dealing with prognostic uncertainty.

The futuristic difference repertoire is not necessarily radical. Our observations indicate that future scenarios are not by definition breaks with the past and the present. Some scholars [55,94–97] argued that notions of evolution and progress dominate the discourse about the future. Some of these authors advance a more discontinuous temporal repertoire. Experience would then be mobilized in a different way, for example, as source of inspiration to think about derailing events and structural changes.<sup>15</sup> So in the scholarly foresight literature a third repertoire can be discerned. In Dutch practice, surprises inducing large-scale changes were brought to the fore. A few futurists did seriously advance a radical discontinuity stance and appeared frustrated with what they experienced as more conventional futures. The idea of discontinuity seems to appeal to futurists, especially in the early phases, but our observations indicate that in the course of a foresight endeavour, radical outlooks get increasingly disqualified as exotic, implausible or unrealistic. In the end, the discontinuous repertoire seem to be marginal in the Dutch community of foresight practice, which is in line with van Notten’s findings on the state of the art in scenario studies [55,97].

#### 4.2.3. *Experience-informed intuition, consultation and consensus*

In interviews with professional futurists as well in the many meetings we attended, references to “expert judgment” are quite ordinary. One of our informants spontaneously qualified foresight as embodiments of collective experience. We heard that “expert judgement is used to assess unknown relationships”, “you may have uncertainty (...), we discuss about it and an expert judgment is passed” and “a large part of the input is expert judgment” (interview quotes). Experience is used as filter to sift uncertainties and as anchor to establish uncertain relationships, inputs and future (policy) effects. The following excerpt of a discussion among futurists exemplifies the role of experience-based intuition:

F. You have to realize that it is a trick that we learned over time (...).

R. I may be too little concerned about the theory behind it, we are working intuitively.

J. Very intuitively.

<sup>15</sup>Van Notten [55] experimented with such an approach in a pilot foresight exercise.

One of them then argued that that also hold for other professional futurists, that they don't do that differently. Later in the discussion another futurist asked about the evaluation of uncertainty:

K. Does that mean that we do it intuitively?

R. Yes.

In the second part of the discussion, it became clear that it is not “just” intuition, but judgement informed by experience:

R. We can consider how [uncertainty] influences the policy recommendations. I am sure that we do that, what is the uncertainty, (..) what is the mistake you may make.

One of the practitioners not directly involved in the foresight activities asserted:

J. I cannot imagine that the people who put the assessment together, have not among themselves thought about issues as ‘can we make this’, ‘can the conclusion be justified’, ‘do we believe this’.

Another question is whose experience is used as anchor. Mesman [59] reports instances in which involved staff discussed the matter with other colleagues. This kind of consultation, through which outsiders' experience is mobilized, also takes place in foresight practice: “if you are uncertain about something, you consult each other” (interview quote). Professional futurists refer to such consultation with notions as “review”, “contra-expertise” and the involvement of “external institutes”. It is explicitly brought forward that consultation is used in case of “unknowns” (interview quote) and to evaluate models which involve prognostic uncertainty. Such consultation does not have to be a formal process involving scheduled meetings and official requests. Our observations indicate that a lot of informal and ad hoc consultation of direct colleagues and external peers is part of the practice as well. Choices on particular details of an image of the future are more than once motivated with reference to such informal bilateral exchanges.

A more thorough form of consultation is explicit consensus-formation. Professional futurists themselves emphasize that because of prognostic uncertainty consensus is sought: “creation of support for the numbers was important. To that end, it was attempted to gain consensus for what we were doing (..) with a large number of external institutes”. A futurist observed that in this process “the edges of [uncertainty] ranges disappear”, while a colleague wondered: “It is striking that we use (..) [consultation] for a reduction or removal of uncertainties”. Although one futurist argued that consultation could be a way to trace uncertainties, our observations yield that consultation is predominantly practised to advance closure around prognostic uncertainty. However, at the same time, our observations indicate that in practice it is often very difficult to reach a consensus. It is beyond the scope of this paper to detail the complexities of consensus formation. We would only like to indicate that consultation and consensus formation is employed in order to deal with uncertainty, but it is not necessarily an easy manner nor by definition successful and effective.

We can conclude that Dutch futurists mobilize experience as a resource in contending with prognostic uncertainty. Experience can be used rather explicitly through the use of

typical exemplars mobilized through temporal repertoires. Our observations do indicate that futurists in practice struggle with temporal repertoires, so this manner is less straightforward than it may seem at first sight. Experience is also enacted in relying on experience-informed intuition, consultation and consensus.

## **5. Conclusion and discussion**

In the current paper, we have indicated that Dutch futurists, consciously or unconsciously, apply different ways to construct solidity and we have discussed the role of experience as an anchor in dealing with prognostic uncertainty. Although not detailed in the current paper, we also witnessed communication habits and the numeric discourse as manners to deal with uncertainty. We would like to emphasize that these manners can be distinguished analytically, but that in practice that distinction not necessarily holds. Furthermore, this is not an exhaustive overview of manners employed in dealing with uncertainty. This paper reports just those uncertainty manners that have become visible through the lens of comparison with the ways in which medical staff appears to deal with prognostic uncertainty. We hope that our detailed but necessarily partial description of what Dutch futurists currently do, may provide them and other practitioners with a vocabulary to reflect on the issue of prognostic uncertainty among themselves and with clients.

To conclude this paper, we would like to look at possible consequences of the observed uncertainty manners. It seems that “certainification” may be the practical outcome. With this notion, we summarize a paradoxical course in which initial uncertainty awareness is compromised by increasing uncertainty intolerance and all kinds of solidifying efforts which in the ends lead to outlooks presented as definite and solid accounts about an uncertain future. On the one hand, it is clear that such certainification enables practitioners to proceed. But the question is whether this is a sustainable strategy in the long run. Prognostic uncertainty pertaining to foresight is much more pronounced in wider public arenas (see, for example, [98]) than is the case in medical practice. Foresight is anyway a more contested activity, so that credibility cannot be established with reference to professional status. In such a context, it is rather easy to question and/or deconstruct the certainty of certainified claims. Certainification may jeopardize basic foresight ambitions of relevance. Those audiences aware of prognostic uncertainty may become annoyed by certainified claims (see, for example, [40]). Second, those decision-makers who had turned to futurists to solve their problems are likely to loose faith when they discover the uncertain character of the certainified claims. One response may be to disregard the long-term assessment all together. But as Jasanoff [99] suggests, it is also feasible that they require even higher levels of certainty which futurists cannot provide. This is likely to result in a rather problematic and troublesome relationship and in the long run it may bring about a deep aversion of any foresight when they feel betrayed time and again. The long-term consequence of certainification may thus be that futurists lose audiences.

We do only sketch one scenario. In that sense, we are as empty handed as futurists often are. We can only hope that our reflection-on-action account stimulates practitioners and scholars involved in foresight to engage in a critical reflection on practical ways practitioners apply in dealing with prognostic uncertainty. It is easy to represent futures studies as an effort in understanding and managing uncertainty, but the experience in Dutch practice indicates that, notwithstanding the perceived progress in concepts, theory

and methodology,<sup>16</sup> the issue of dealing with prognostic uncertainty in actual foresight endeavours deserves more serious, critical and systematic attention as well as empirical inquiry.

## Acknowledgements

First of all, we thank our informants in medical and foresight practice. Without their participation, we would not have been able to write this paper. A very first draft has been presented at the 4S conference (Society for Social Studies of Science) in Atlanta (2003) and at a so-called BOTS colloquium at our faculty. We reserve a special word of thanks to Jerry Ravetz, Rein de Wilde, Dave Huitema, Wiebe Bijker and Helga Nowotny for their fruitful suggestions. We also benefited from Marjolein's visiting scholarship with the James Martin Institute at the Saïd Business School of Oxford University, especially Steve Woolgar, Dan Neyland, James Tansey, Steve Rayner, Christian Toennessen and Ju Min Wong. Furthermore, we thank the two anonymous reviewers. Their challenging comments stimulated us to rethink and nuance our findings. Finally, we thank the Dutch Science Foundation (NWO), as well as the university and our faculty, for the necessary financial means.

## References

- [1] de B. Laat, Scripts for the future: using innovation studies to design foresight tools, in: N. Brown, B. Rappert, A. Webster (Eds.), *Contested Futures: A Sociology of Prospective Techno-Science*, Ashgate, Aldershot, UK, 2000.
- [2] M.B.A. van Asselt, The complex significance of uncertainty in a risk era: logics, manners and strategies in use, *International Journal for Risk Assessment and Management* 5 (2/3/4) (2005) 125–158.
- [3] E. Fontela, Bridging the gap between scenarios and models, *Foresight* 2 (10) (2000) 10–14.
- [4] M. Puglisi, S. Marvin, Developing urban and regional foresight: exploring capacities and identifying needs in the North West, *Futures* 34 (8) (2002) 761–777.
- [5] R. Cinquegrani, Futurist networks: cases of epistemic community?, *Futures* 34 (8) (2002) 779–783.
- [6] G. Burt, K. van der Heijden, First steps: towards purposeful activities in scenario thinking and future studies, *Futures* 35 (10) (2003) 1011–1026.
- [7] B.E. Tonn, The future of futures decision making, *Futures* 35 (6) (2003) 673–688.
- [8] A. Wilkinson, E. Eidinow, A brief introduction to building and using scenarios, *Journal of Risk Research* 6 (4–6) (2003) 295–296.
- [9] A. Wilkinson, S. Elahi, E. Eidinow, Riskworld scenarios, *Journal of Risk Research* 6 (4–6) (2003) 297–334.
- [10] P.D. Aligica, Prediction, explanation and the epistemology of future studies, *Futures* 35 (10) (2003) 1027–1040.
- [11] P.J. Dortmans, E. Eiffe, An examination of future scenarios using historical analogy, *Futures* 36 (10) (2004) 1049–1062.
- [12] P. Hayward, Futures studies as a catalyst for change, *Futures* 36 (5) (2004) 611–616.
- [13] P.D. Aligica, The challenge of the future and the institutionalization of interdisciplinarity: notes on Herman Kahn's legacy, *Futures* 36 (1) (2004) 67–83.
- [14] G. Hofstede, *Cultures and Organization: Software of the Mind*, McGraw-Hill, London, UK, 1991.
- [15] M. Lin, Certainty as a social metaphor: the social and historical production of certainty in China and the West. *Contributions in Philosophy*—No. 79, Greenwood Press, Westport, CT, USA, 2001.
- [16] H. Nowotny, P. Scott, M. Gibbons, *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty*, Polity Press in association with Blackwell Publishers, Cambridge, UK, 2001.

<sup>16</sup>See, for example, [10], but such claims can be found in many articles in the main futurists' journals, such as *Futures* and *Technological Forecasting and Social Change*.

- [17] S.O. Funtowicz, J.R. Ravetz, Uncertainty and quality in science for policy, in: W. Leinfellner, G. Eberlein (Eds.), *Philosophy and Methodology of the Social Sciences*, Kluwer, Dordrecht, The Netherlands, 1990.
- [18] G.M. Morgan, M. Henrion, *Uncertainty—A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis*, Cambridge University Press, New York, USA, 1990.
- [19] B. Wynne, Uncertainty and environmental learning: reconceiving science and policy in the preventive paradigm, *Global Environmental Change* 2 (1992) 111–127.
- [20] J.P. van der Sluijs, *Anchoring amid Uncertainty: on the Management of Uncertainties in Risk Assessment of Anthropogenic Climate Change*, Universiteit Utrecht, Utrecht, The Netherlands, 1997.
- [21] M.B.A. van Asselt, *Perspectives on Uncertainty and Risk: The PRIMA Approach to Decision Support*, Kluwer Academic Publishers, Dordrecht, The Netherlands, 2000.
- [22] M.P. Kraymer von Kraus, M.B.A. van Asselt, M. Henze, J. Ravetz, M.B. Beck, Uncertainty and precaution in environmental management, *Water, Science and Technology* 52 (6) (2005) 1–9.
- [23] D.A. Schön, *The Reflective Practitioner: How Professionals Think in Action*, Basic Books, USA, 1983.
- [24] N. Brown, B. Rappert, A. Webster, *Contested Futures: A Sociology of Prospective Techno-Science*, Ashgate, UK, Aldershot, 2000.
- [25] M. Cariola, S. Rolfo, Evolution in the rationales of foresight in Europe, *Futures* 36 (10) (2004) 1063–1075.
- [26] S. Inayatullah, Deconstructing and reconstructing the future: predictive, cultural and critical epistemologies, *Futures* 22 (2) (1990) 115–141.
- [27] P. Schwartz, *The Art of the Long View: Planning for the Future in an Uncertain World*, Currency Doubleday, New York, 1991.
- [28] K. van der Heijden, *Scenarios: the Art of Strategic Conversation*, Wiley, England, 1996.
- [29] Z. Sardar (Ed.), *Rescuing all our Futures: the Future of Futures Studies*, Praeger, Westport, 1999.
- [30] R.A. Slaughter, *Futures for the Third Millennium: Enabling the Forward View*, Prospect Media, Australia, 1999.
- [31] W. Bell, *Foundations of Futures Studies: Human Science for a New Era*, vol. 1, Transaction Publishers, New Brunswick, 2000.
- [32] B. Latour, S. Woolgar, *Laboratory Life: The Construction of Scientific Facts*, second edition with new postscript by the authors, Princeton University Press, Oxford, UK, 1986.
- [33] K. Knorr Cetina, *Laboratory studies: the cultural approach to the study of science*, in: S. Jasanoff, G.E. Markle, J.C. Petersen, T. Pinch (Eds.), *Handbook of Science and Technology Studies*, Sage, London, 1995.
- [34] M. Hammersley, P. Atkinson, *Ethnography: Principles in Practice*, second ed., Routledge, London and New York, 1995.
- [35] S. Woolgar, *Science: the Very Idea*, Routledge, Ellis Horwood, 1988.
- [36] M.B.A. van Asselt, S.A. van't Klooster, P.W.F. van Notten, Foresight in uncertainty, *Beleid en Maatschappij* 30 (4) (2003) 230–241 (in Dutch).
- [37] M.B.A. van Asselt, Foresight and the art of uncertainty communication, *Beleidswetenschap* 18 (2) (2004) 137–168 (in Dutch).
- [38] S.A. van't Klooster, M.B.A. van Asselt, Practicing the scenario-axes technique, *Futures* 38 (1) (2006) 15–30.
- [39] E. Dammers, *Learning from the Future: on the Role of Scenarios in Strategic Policy-making*, Eburon, Delft, The Netherlands, 2000 (in Dutch).
- [40] J. Schooneboom, Future scenarios and policy, *Beleid en Maatschappij* 30 (4) (2003) 212–218 (in Dutch).
- [41] P.M. van der Staal, F.A. van Vught, Fifteen years of future research by the WRR: delayed methodological reflection part I, *Beleidsanalyse* 87 (4) (1987) 16–25 (in Dutch).
- [42] M. Hollinshead, Book review, *Futures* 35 (4) (2005) 337–344.
- [43] Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, *Houdbaarheid verstreken: Toekomstverkenning en beleid*, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, Den Haag, 2005.
- [44] WRR, *Future studies in retrospect*, WRR—Stuurgroep Toekomstonderzoek en strategisch omgevingsbeleid, The Hague, The Netherlands, 2000 (in Dutch).
- [45] RIVM, *National Environmental Outlook 5 2000–2030*, Alphen aan de Rijn, The Netherlands, Samson, 2000 (in Dutch).
- [46] E. Dobbinga, *The Persistence of Organisational Culture: an Organisational-Anthropological Study to the Meaning of Modern Management Tools*, Eburon, Delft, The Netherlands, 2001 (in Dutch).
- [47] P.A. van der Duin, C.A. Hazeu, P. Rademaker, I.J. Schooneboom (Eds.), *Twente-Five Years Later: the 1977 Future Study of the WRR as Learning Process*, WRR verkenningen, Amsterdam University Press, Amsterdam, The Netherlands, 2004 (in Dutch).
- [48] R.A. Slaughter, M. Garret, Towards an agenda for institutions of foresight, *Futures* 27 (1) (1995) 91–95.

- [49] M. Keenan, An Evaluation of the Implementation of the UK Technology Foresight Programme, in PREST, The University of Manchester, Manchester, UK, 2000.
- [50] A. Alsan, M. Atilla Oner, Comparison of national foresight studies by integrated foresight management model, *Futures* 36 (8) (2004) 889–902.
- [51] E. Blass, Researching the future: method or madness?, *Futures* 35 (10) (2003) 1041–1054.
- [52] M.B.A. van Asselt, C.A.H.M. Storms, N. Rijkens-Klomp, J. Rotmans, Towards Visions for a Sustainable Europe: an Overview and Assessment of the Last Decade of European scenario-Studies, ICIS, Maastricht, The Netherlands, 1998.
- [53] S.C.H. Greeuw, M.B.A. van Asselt, J. Grosskurth, C.A.M.H. Storms, N. Rijkens-Klomp, D.S. Rothman, J. Rotmans, Cloudy crystal balls: an assessment of recent European and global scenario studies and models, European Environmental Agency (EEA) Experts' Corner Report No. 4: Prospects and Scenarios, Copenhagen, Denmark, 2000.
- [54] P. van Notten, J. Rotmans, M.B.A. van Asselt, D.S. Rothman, An updated scenario typology, *Futures* 35 (2003) 423–443.
- [55] P.W.F. van Notten, Writing on the wall: scenario make development in times of discontinuity, Thela Thesis & Dissertation.com, Amsterdam, The Netherlands, 2005.
- [56] J. Rotmans, B. de Vries, Perspectives on Global Change: the TARGETS Approach, Cambridge University Press, Cambridge, 1997.
- [57] B. Kasemir, J. Jäger, C. Jaeger, M.T. Gardner (Eds.), Public Participation in Sustainability Science, Cambridge University Press, Cambridge, UK, 2003.
- [58] M.B.A. van Asselt, J. Rotmans, D.S. Rothman, Scenario Innovation: Experiences from a European Experimental Garden, Taylor & Francis, London, 2005.
- [59] J. Mesman, Experienced Pioneers: Dealing with Doubt in the Intensive Care for Neonates. Health, Culture and Society, Aksant, Amsterdam, The Netherlands, 2002 (in Dutch).
- [60] J. Mesman, Prognostic differences and their origins: a topography of experience and expectation in a neonatal intensive care unit, *Qualitative Sociology* 28 (1) (2005) 49–66.
- [61] J. Mesman, Channeling erratic flows of actions: life in the neonatal intensive care unit, in: C. Owen, G. Wackers, J. Gregory (Eds.), *Risky Work: The Ecologies of Human Work with-in Complex Technological systems*, MIT Press, Cambridge, USA, forthcoming.
- [62] R. Fox, Training for uncertainty, in: R.K. Merton, G.G. Reader, P.L. Kendall (Eds.), *The Student-Physician: Introductory Studies in the Sociology of Medical Education*, Harvard University Press, Cambridge, USA, 1957.
- [63] C.L. Bosk, *Forgive and Remember: Managing Medical Failure*, The University of Chicago Press, Chicago, USA, 1979.
- [64] C.L. Bosk, Occupational rituals in patient management, *New England Journal of Medicine* 303 (2) (1980) 71–76.
- [65] P. Atkinson, Training for certainty, *Social Science and Medicine* 19 (9) (1984) 949–956.
- [66] J. Katz, Why doctors don't disclose uncertainty, *The Hasting Centre Report*, February 1984, pp. 35–44.
- [67] R. Fox, *Essays in Medical Sociology: Journeys into the Field*, second enlarged ed., Transaction Books, Oxford, 1988.
- [68] R. Fox, Medical uncertainty revisited, in: G.L. Albert, R. Fitzpatrick, S.C. Scrimshaw (Eds.), *Handbook of Social Studies in Health and Medicine*, Sage, London, UK, 2000.
- [69] R. Zussman, *Intensive Care: Medical Ethics and the Medical Profession*, The University of Chicago Press, Chicago, USA, 1992.
- [70] W. Halffman, R. Hoppe, Science/policy boundaries: a changing division of labour in Dutch expert policy advice, in: S. Maasse, P. Weingart (Eds.), *Democratization of expertise? Exploring novel forms of scientific advice in political decision-making*, Kluwer, Dordrecht, the Netherlands, 2005, pp. 135–152.
- [71] T.F. Gieryn, Boundaries of science, in: S. Jasanoff, G.E. Markle, R.E. Petersen, T. Pinch (Eds.), *Handbook of Science and Technology Studies*, Sage, London, UK, 1995.
- [72] T.F. Gieryn, Boundary-work and the demarcation of science from non-science: strains and interests in professional ideologies of scientists, *American Sociological Review* 48 (1983) 781–795.
- [73] R. Bal, W.E. Bijker, R. Hendriks, *The Paradox of Scientific Authority: on the Societal Impact of the Health Council Advices*, Gezondheidsraad/Dutch Health Council, The Hague, The Netherlands, 2002 (in Dutch).
- [74] D.J. Hess, Technology- and product-oriented movements: approximating social movement studies and science and technology studies, *Science, Technology and Human Values* 30 (4) (2005) 515–535.



- [75] J.P. van der Sluijs, J.C.M. van Eijndhoven, B. Wynne, S. Shackley, Anchoring devices in science for policy: the case of consensus around climate sensitivity, *Social Studies of Science* 28 (2) (1998) 291–323.
- [76] M. Douglas, *Environments at risk*, in: J. Beuthall (Ed.), *Ecology: the Shaping Enquiry*, Longman, London, UK, 1969.
- [77] M. Douglas (Ed.), *Essays in the Sociology of Perception*, Routledge and Kegan Paul, London, UK, 1982.
- [78] M. Douglas, A. Wildavsky, *Risk and Culture: Essays on the Selection of Technical and Environmental Dangers*, University of California Press, Berkley, USA, 1982.
- [79] S. Rayner, Cultural theory and risk analysis, in: G.D. Preagor (Ed.), *Social Theory of Risk*, Westport, USA, 1992.
- [80] M. Schwarz, M. Thompson, *Divided we Stand: Redefining Politics, Technology and Social Choice*, Harvester Wheatsheaf, New York, USA, 1990.
- [81] M. Thompson, R. Ellis, A. Wildavsky, *Cultural Theory*, Westview Press, Boulder, USA, 1990.
- [82] M.B.A. van Asselt, J. Rotmans, Uncertainties in perspective, in: J. Rotmans, B. de Vries (Eds.), *Perspectives on Global Change: the TARGETS Approach*, Cambridge University Press, Cambridge, UK, 1997.
- [83] M.B.A. van Asselt, J. Rotmans, Uncertainty in perspective, *Global Environmental Change* 6 (2) (1996) 121–157.
- [84] A.Y. Hoekstra, Appreciation of water: four perspectives, *Water Policy* 1 (1998) 605–622.
- [85] A.Y. Hoekstra, *Perspectives on Water: an Integrated Model-Based Exploration of the Future*, International Books, Utrecht, 1998.
- [86] M. Janssen, B. de Vries, The battle of perspectives: a multi-agent model with adaptive responses to climate change, *Ecological Economics* (1998) 43–65.
- [87] J. Rotmans, M.B.A. van Asselt, Perspectives on a sustainable future, *International Journal for Sustainable Development* 2 (2) (1999) 201–230.
- [88] M.B.A. van Asselt, H. Middelkoop, S.A. van 't Klooster, W.P.A. van Deursen, M. Haasnoot, J.C.J. Kwadijk, H. Buiteveld, G.P. Können, J. Rotmans, N. van Gemert, P. Valkering, Development of flood management strategies for the Rhine and Meuse basins in the context of integrated river management, Report of the IRMA-SPONGE Project 3/NL/1/164/99 15 183 01, Maastricht/Utrecht, The Netherlands, 2001.
- [89] H. Hilderink, World population in transition, an integrated regional modelling framework. population studies, Thela Thesis, Amsterdam, 2000.
- [90] R.E. O'Connor, B. Yarnal, K. Dow, C.L. Jocoy, G.J. Carbone, Feeling at risk matters: water managers and the decision to use forecasts, *Risk Analysis* 25 (5) (2005) 1265–1275.
- [91] R. Koselleck, *Futures Past: on the Semantics of Historical Time*. Studies in Contemporary German Social Thought, MIT Press, Cambridge, USA, 1985.
- [92] S.A. van't Klooster, *Futures studies: ambitions and practice*, Faculty of Arts and Social Sciences, Maastricht University, Maastricht, The Netherlands (in Dutch), in preparation.
- [93] E. Dammers, H.L. Pálsdóttir, F. Stroecken, L. Crommentuijn, E. Driessen, F. Fillius, SCENE: a Quartet Spatial Scenarios for The Netherlands, NAI Publishers & The Netherlands Institute for Spatial Research (RPB), Rotterdam and The Hague, The Netherlands, 2003 (in Dutch).
- [94] W.C. Clark, Visions of the 21st century: conventional wisdom and other surprises in the global interactions of population, technology and environment, in: K. Newton, T. Schweiter, J.P. Voyer (Eds.), *Perspective 2000*, Economic Council of Canada, 1988.
- [95] D. Morgan, Images of the future: a historical perspective, *Futures* 34 (9/10) (2002) 883–893.
- [96] R. de Wilde, *The Prophets: a Critique on the Future Industry*, Uitgeverij De Balie, Amsterdam, The Netherlands, 2000 (in Dutch).
- [97] P.W.F. van Notten, A.M. Slegers, M.B.A. van Asselt, The future shocks: on the role of discontinuity in scenario development, *Technological Forecasting and Social Change* 72 (2005) 175–194.
- [98] O. Todt, Designing trust, *Futures* 35 (3) (2003) 239–251.
- [99] S. Jasanoff, Acceptable evidence in a pluralistic society, in: D.G. Mayo, R.D. Hollander (Eds.), *Acceptable Evidence: Science and Values in Risk Management*, Oxford University Press, New York, USA, 1991.