TEXTE
59/2020

Employing trend analysis in environmental research and policy – a methods report

Final Report

For our Environment

Umwelt Bundesamt

TEXTE 59/2020

Environmental Research of the
Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

Project No. (FKZ) 3714 17 102 0
Report No. FB000184/ENG

Employing trend analysis in environmental research and policy – a methods report

Final Report

by

Benno Keppner, Walter Kahlenborn, Daniel Weiß
adelphi, Berlin

Stephan Richter, Tobias Jetzke, Marc Bovenschulte
iit, Berlin

On behalf of the German Environment Agency

Imprint

Publisher:
Umweltbundesamt
Wörlitzer Platz 1
06844 Dessau-Roßlau
Tel: +49 340-2103-0
Fax: +49 340-2103-2285
buergerservice@uba.de
Internet: www.umweltbundesamt.de

/umweltbundesamt.de
/umweltbundesamt

Study performed by:
adelphi research gGmbH
Alt-Moabit 91
D-10559 Berlin

Institut für Innovation und Technik
Steinplatz 1
10623 Berlin

Study completed in:
May 2019

Edited by:
Section I 1.1 Fundamental Aspects, Sustainability Strategies and Scenarios, Sustainable Resource Use
Sylvia Veenhoff

Publication as pdf:
http://www.umweltbundesamt.de/publikationen

ISSN 1862-4804

Dessau-Roßlau, May 2020

Abstract: Trend analysis for environmental research and policy – methods report

This report outlines for environmental policy how the research method “trend analysis” can support the analysis of environmentally relevant developments. Trend analyses generally encompass the description of a trend and the systematic analysis of its impact on the environment. In this way, they can contribute to making environmental policy more effective and to shape trends in an anticipatory manner.

Kurzbeschreibung: Trendanalysen für Umweltforschung und -politik – Methodenpapier

Dieses Methodenpapier skizziert für die Umweltpolitik, wie das Instrument der „Trendanalyse“ für die Untersuchung von umweltrelevanten Entwicklungen nutzbar gemacht werden kann. Durch Trendanalysen können die verschiedenen Facetten eines Trends beschrieben werden und diese systematisch hinsichtlich ihrer Wirkungen auf die Umwelt analysiert werden. Trendanalysen können so dazu beitragen, die Umweltpolitik im Sinne einer antizipativen Politikgestaltung handlungsfähig zu machen.

Table of Contents

Table of figures

List of tables

Summary

Currently, there is no consistent research method with which to analyse social, technological, economic or political trends that have no obvious connection to the environment, and to systemically identify and assess the complex, interdependent and often indirect effects of these trends. This report offers practical insights on how a trend analysis may be carried out. This report is to provide a theoretical foundation for the trend analysis. The method outlined was used in this research project to analyse two trends – the increasing use of 3D printing in industry and society, and the impact of digitization on consumption (Consumption 4.0).

Trend selection and preliminary explanations

There are different ways in which to gauge the relevance of a trend's impact on the environment and for it to become the potential object of (trend) analyses. For example, horizon scanning processes identify environmentally relevant developments. Current political demand to analyse important topics of future relevance may also necessitate trend analyses as well as the public discussion of topics.

Core criteria for selecting potential trends for the Ministry of the Environment are:

- environmental relevance: the intensity and form in which the trend impacts on the environment in comparison to a reference system;
- novelty: to what extent the topic is already part of environmental policy-making and ministerial research;
- plausibility: whether the trend will gain significance in future.

Each trend is distinct. Therefore, each trend analysis must specifically be explained in a preliminary clarification. This should include:

- an operational clarification: for each trend analysis the material and time resources are determined;
- content-related clarifications: building on the determination of resources, the scope of the analysis is defined (research object and research aim).
- methodological clarifications: as a function of the research object and research aim methodological details are determined;
- work plan: the different predefinitions are subsequently integrated in a work plan.

Method used for describing a trend

Building on the preliminary explanation the trend is described. A comprehensive and detailed description of a trend is the foundation for the further procedure and needs to be carefully conducted; in particular, it should give – to the extent possible – an overview of all trend-related data, facts and projections. A comprehensive understanding of the context, driving forces and "anatomy" of a trend facilitates the analysis of its implications for the environment. It is important that the trend description systematically identifies – to the extent possible – all those trend aspects that are directly and indirectly in a potential relationship with the environment. A detailed trend description supports a fine-grained understanding of a trend and functions as foundation for detecting the past, current and potential future environmental impacts of a trend.

Method to determine the environmental impact of a trend

Following the trend description, the direct and indirect, positive and negative environmental impacts of trends are assessed. To identify them, two methods were used within this research project: impact assessment and the IIC method. Both these methods differ: the impact assessment is primarily causal-analytical and focuses on the short- and medium-term future, while the IIC method is creative and focuses on the innovative aspects of a trend, reflecting on the environmental impacts these aspects

may have when projected into the future. Both methods have been combined to comprehensively identify the short-, medium- and long-term impacts.

Policy and research recommendations

In the final step of the analysis, policy and research recommendations are developed. This aims to transfer the previously generated assessments to concrete political and research-related starting points. Core questions for developing these recommendations are:

- Which environmental impacts need to be addressed as high priority? Which environmental objectives can be derived (e. g. the reduction of environmental burdens, support of individual aspects relieving the environment)
- Which options exist for the Ministry of the Environment, other German ministries and organisations at the EU and international level to address the environmental impacts?

Once the trend analysis has been completed, the recommendations should be implemented. A central goal is to initiate follow-up activities to transfer the implementing process addressing risks and opportunities to committed actors.

Zusammenfassung

Bislang existiert noch keine konsistente Methode, mit deren Hilfe gesellschaftliche, technische, wirtschaftliche oder politische Trends, die keinen offensichtlichen Umweltbezug haben, so analysiert werden können, dass die komplexen, interdependenten und oft indirekten Wirkungen systematisch erfasst und eingeschätzt werden können. Das vorliegende Methodenpapier soll eine Diskussionsgrundlage schaffen, wie eine Analyse der Umweltwirkungen von Trends gelingen kann.
Das Methodenpapier ist in diesem Sinne eine theoretische Grundlage. Die hier vorgestellte Methode wurde darüber hinaus auch im Rahmen des Vorhabens „Analyse und Bewertung der Wirkungen von umweltrelevanten Trends auf die Umweltpolitik mit Hilfe der Methode der Trendanalyse, FKZ 3714 17 102 0“ für zwei Trends pilothaft angewandt, nämlich für die zunehmende Nutzung des 3D-Drucks in Industrie und Gesellschaft und die Veränderung des Konsums im Zuge der Digitalisierung (Konsum 4.0).
Auswahl von Trends und grundlegende Vorklärungen
Trends werden auf unterschiedlichen Wegen als umweltrelevant eingeschätzt und werden so zu einem potenziellen Objekt für Trendanalysen. So können beispielsweise in einem Horizon-Scanning-Prozess besonders umweltrelevante Entwicklungen erfasst werden. Auch aus aktuellem politischem Handlungsbedarf, sich ad hoc mit einem Zukunftsthema vertieft auseinanderzusetzen, kann die Notwendigkeit erwachsen, eine Trendanalyse durchzuführen oder schlichtweg, da ein Thema in öffentlichen Diskursen besonders stark diskutiert wird.
Zentrale Kriterien für die Auswahl von potenziellen Trendthemen für das Umweltressort können sein:
► Umweltrelevanz, das heißt mit welcher Stärke und auf welche Weise sich der Trend auf die Umwelt im Vergleich zu einem Referenzsystem auswirkt;
► Neuigkeit des Themas, das heißt inwieweit das Thema schon vom Umweltressort bearbeitet und auch in der Ressortforschung schon untersucht wurde;
► Plausibilität des Trendthemas, das heißt inwieweit der Trend in Zukunft an Bedeutung gewin-nen wird.

Jeder Trend ist verschieden. Daher müssen vor einer Trendanalyse die Vorklärungen für jeden Trend spezifisch geklärt werden. Wesentliche Arbeitsschritte der Vorklärung sind:
► Operative Vorklärungen: für identifizierte Trends wird festgelegt, welche sachlichen und zeitli-chen Mittel zur Verfügung stehen;
► Inhaltliche Vorklärungen: aufbauend auf der Ressourcenfestlegung wird der inhaltliche Um-fang der Untersuchung festgelegt (Untersuchungsgegenstand; Zielstellung);
► Methodische Vorklärungen: anschließend werden in Abhängigkeit vom Untersuchungsgegen-stand und Zielstellung methodische Details bestimmt;
► Projektarbeitsplan: die einzelnen Vorklärungen werden abschließend in einem Arbeitsplan zusammengeführt.

Methode zur Trendbeschreibung
Aufbauend auf den operativen, inhaltlichen und methodischen Vorklärungen wird der Trend be-schrieben. Eine umfassende und detaillierte Beschreibung eines Trends bildet das Grundgerüst für das weitere Vorgehen und muss daher sorgfältig erstellt werden und soweit wie möglich einen Überblick über alle Daten, Fakten und Prognosen geben. Je besser man die Hintergründe, treibenden Kräfte und die „Anatomie“ eines Trends versteht, desto präziser kann er später hinsichtlich seiner Implikationen auf die Umwelt ausgewertet werden. Wichtig ist, dass eine Trendbeschreibung alle diejenigen Aspekte eines Trends gut strukturiert und übersichtlich erfasst, die potenziell mit (direkten und indirekten) Umweltwirkungen in Zusammenhang stehen könnten. Eine detailliertere Trendbeschreibung dient damit zum einen dem tieferen Verständnis des Trends, zum anderen als Grundlage für die Erhebung der vergangenen, jetzigen und möglichen zukünftigen Umweltauswirkungen des Trends.
Methode zur Erhebung der Umweltauswirkungen von Trends
Nach der Beschreibung des Trends folgt der Kern der Analyse: die Erhebung der direkten und indirekten, positiven und negativen Umweltauswirkungen von Trends. Für die Bestimmung der Umweltaus-

wirkungen wurde im Vorhaben auf zwei Methoden zurückgegriffen: das Impact-Assessment und das IIC-Verfahren. Beide unterscheiden sich voneinander: Während das Impact-Assessment primär kausalanalytisch auf die kurz- und mittelfristige Zukunft ausgerichtet ist und die (direkten und indirekten) Wirkungen des Trends auf die Umwelt erhebt, ist das IIC-Verfahren ein kreatives Verfahren, das mit visionärer Brille auf die innovativen Aspekte des Trends fokussiert und reflektiert, welche Umweltauswirkungen diese innovativen Aspekte mit sich bringen könnten, wenn sie konsequent in die fernere Zukunft weitergedacht werden würden. Beide Methoden wurden für das Vorhaben kombiniert, um eine Bandbreite an potenziellen kurz-, mittel- und langfristigen Umweltwirkungen in der Umweltbewertung zu erfassen.

Handlungs- und Forschungsempfehlungen

Im letzten Schritt der Analyse werden Handlungs- und Forschungsempfehlungen entwickelt. Dies hat zum Ziel die zuvor erarbeiteten Einschätzungen in konkrete, politische und wissenschaftliche Ansatzpunkte zu übertragen. Zentrale Fragestellungen für die Entwicklung der Handlungs- und Forschungsempfehlungen sind unter anderem:

- Welche Umweltauswirkungen sind prioritär politisch zu bearbeiten? Und welche umweltpolitischen Ziele leiten sich hieraus ab (beispielsweise Minderung bestimmter Belastungen, Unterstützung einzelner umweltentlastender Aspekte)?
- Welche Möglichkeiten und Kompetenzen hat das BMU, um die Umweltauswirkung anzugehen und die formulierten Ziele zu erreichen?
- Welche Möglichkeiten haben andere Ressorts in Deutschland bzw. Organisationen auf EU- und internationaler Ebene, um die Umweltauswirkungen zu bearbeiten?

Am Ende des Prozesses sollten die Ergebnisse außerdem in die Umsetzung transferiert werden. Hier gilt es, Follow-Up-Aktivitäten zu initiieren, um den Umsetzungsprozess zur Vermeidung bzw. Reduzierung von Umweltrisiken sowie zur Nutzung von Chancen in engagierte Hände zu übergeben.

1 Background and objectives

Apart from dealing with environmental problems that have already been identified, environmental policy also faces the challenge of identifying possible future environmental burdens and relief that are largely unknown. One analytical approach is to analyse the trends that have a direct or indirect, positive and/or negative impact on the environment. The environmental impacts arising with megatrends have been analysed for some time (Retief et al. 2016). What is often mentioned and discussed in public debate, for instance, is the environmental impact posed by increasing urbanisation, demographic change and the growing acceleration of technological innovations (EEA 2015). This report focusses on the development of methods for trends that have so far not been analysed in depth. This includes, for instance, individual technologies that are currently still being researched, but that have the potential to spread from a niche to a wider sphere of application. This could also include social, economic or political changes that are currently only starting to emerge.

In the thicket of perceived changes, diffuse signals and opinions about potential trends, it is not easy to orientate oneself towards environmental policy, but it is necessary. As the development of the mobile phone shows, technologies can expand from a niche product to one that is widely used, irreversibly changing our way of life, and lead to environmental pollution (e.g. coltan mining) and/or environmental relief (e.g. sharing economy). Further negative examples from the past underline this (EEA 2001). These include, for example, the periodically extensive use of carcinogenic asbestos as a building material and the once heavy use of CFCs (chlorofluorocarbons) in solvents and refrigerants, which contributed to ozone depletion in the stratosphere (EEA 2001). Trends thus have the potential to i) intensify or reduce existing environmental problems and ii) to generate entirely new environmental problems.

Two central objectives arise from this. Emerging trends must constantly be monitored in a horizon-scanning process and classified according to their environmental relevance. Such "environmentally relevant" changes must be examined in more depth in trend analyses with regard to their possible future development and associated environmental impact.

Horizon Scanning is a method of futurology that is not only used for strategic forecasts by the Federal Environment Agency and the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, but is also established in many other political institutions (cf. Horizon Scanning project as an instrument in environmental policy for strategic early warning and efficient policy advice, FKZ 3712 11 104). The Ministry of the Environment's Horizon Scanning method is used to systematically identify emerging developments that have, in the first instance, been classed as "environmentally relevant" and, secondly, have not yet been actively addressed by the Ministry.

The environmentally relevant developments identified by horizon scanning and other methods (brainstorming, ad hoc action required due to emerging public or political discourses, etc.) are then analysed in depth using trend analyses. This methods report outlines how this futurology tool can be used for the analysis of trends for environmental policy. The in-depth analysis should provide an overview of the various facets of the trend, examine them systematically with regard to their current and potentially future environmental impact and thus help to make environmental policy more responsive so that it can respond pro-actively to these new trends. The analysis of environmental impacts focuses on possible future environmental impacts of trends, and also includes past and present impacts.

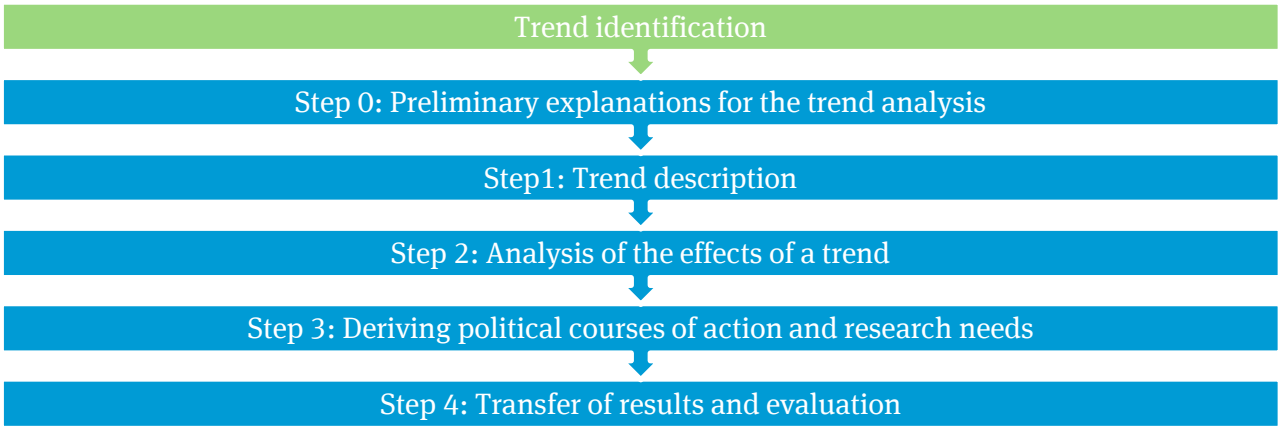
In principle, a trend analysis is the investigation of a trend with regard to its "nature, causes, developmental speeds and possible consequences" (translated according to Cornish 2005: 78). In contrast to scenario analyses, trend analyses are not based on various visions of the future, but try to create an understanding of how a trend might develop further on the basis of a scientifically-based understanding of the past development of a trend as well as an examination of the current state of a

trend, and thus of the "starting point" for its future development (explorative understanding of the future). [1] The basic assumption is that "the future is a continuation of the past" (Duinker and Greig, 2007: 209).

Trend analyses focus on two objectives: Firstly, on gaining a deeper understanding of the causes and drivers of a previously identified trend in order to identify starting points for being able to politically address a trend and its future development (Cornish 2005) and, secondly, on trying to gain – as systematically as possible – deeper insights into the potential effects of the trend in order to take into account effects that might not be as obvious. Thirdly, apart from understanding a trend and its development as well as recognising its environmental impact, a trend analysis in the political context also requires political options for action to be derived. Fourthly, the results of the analysis must be translated into concrete political discourse (transfer of results) so that political action can be taken in response to the emerging trends.

From the above, we can derive ideal-typical phases of a trend analysis to support the Ministry of the Environment (see Figure 1). In a first step – the trend description – actors, drivers, causes of the trend as well as past developments, the current state of a trend and, where possible, quantitative assumptions about its future development are presented in a substantiated manner. The elements of the trend, that are environmentally relevant, i.e. that may have a direct or indirect impact on the environment, are addressed. In a second step, the possible effects of a trend are identified (positive as well as negative, direct and, as far as possible, indirect). Thirdly, starting points and options for action for environmental policy are developed and research needs are identified. Fourthly, the results are transferred to science for further processing and/or to politics, where they will ultimately be incorporated into policy-making, in the form of proactive policy-making. For example, proactive policy-making may mean working with companies at an early stage to design products from the outset in such a way that negative environmental impacts are avoided. The analysis is preceded by the identification of trends and the determination of the research orientation (step 0: preliminary explanation of the trend analysis).

Figure 1: Phases of the environmental trend analysis (blue) as well as the preliminary analytical steps taken (green)



In its study "Mapping Europe's Environmental Future", the European Environment Agency has developed a proposed methodology for analysing the implications of global megatrends in EU member states (EEA 2017). In the report "SOER 2015 – The European environment – state and outlook 2015",

[1] However, trend analyses may support the development of scenarios, for example, by supplementing the development projected in the context of a trend analysis with other future visions formulated to distinguish them from the continuation of the trend (e.g. normative scenarios, negative scenarios or explorative alternative scenarios).

the European Environment Agency examines the state of the environment as well as future trends and their implications for the achievement of the environmental goals (EEA 2015). In the Global Environmental Outlook Process, UN Environment regularly examines the global state of the environment and trends.

This methods report builds on these processes. It faces the fundamental challenge that a scientific consensus on the term "trend" or a uniform definition of it does not yet exist. The literature contains different, sometimes contradictory understandings, but also attempts to come up with a more precise definition (see v. Groddeck 2013; Liebl 2010; Holopainen 2012; Mendonça 2012). These different definitions are also an expression of different methodological understandings or the methodological dispute between qualitative and quantitative social and policy research. Thus, trends are understood as (examples from Liebl 2010):

- being synonymous with a weak signal;
- particularly important topics;
- predicting the future development of a time series (time series analysis);
- drivers that affect a scenario;
- changes of any kind;
- innovations that hold the potential for particularly great strategic surprises.

The understanding of trends, which underpins this report, goes beyond seeing trends merely as important issues. A trend is understood in this methods report as a "reality that has existed for some time, is developing, is not cyclical and is describable (in empirical, statistical terms)" (UBA 2014).

Trends can be categorized differently depending on time frame, duration, social significance, clarity of expression and accompanying factors. The Zukunftsinstitut (Future Institute), for example, distinguishes between metatrends, megatrends, socio-cultural trends, consumer and zeitgeist trends and product and fashion trends (cf. Zukunftsinstitut 2015). Metatrends, megatrends, trends (in the areas of society, technology, economy, politics and the environment) and emerging issues (cf. Behrendt et al. 2015) are relevant for a political trend and environmental impact analysis.

Metatrends can be seen as "evolutionary constants of nature" (Zukunftsinstitut 2015). They describe changes in ecosystems over a very long period of time (millennia to millions of years) and describe "ups and downs of species" and specific habitats (Zukunftsinstitut 2015). From this perspective, metatrends play a role, for example, in the context of discussions about planetary borders, the Anthropocene period or, specifically, in the field of climate protection.

A megatrend is generally understood to be a particularly profound, comprehensive trend that is valid in its fundamental direction in the long term and "universal" (i.e. all-encompassing and global in character), but can vary in its respective manifestation at the local level and, therefore, sometimes remains blurred (Naisbitt 1982). Although experts have a basic common understanding of a certain selection of megatrends (demographic change, climate change, individualisation, etc.), there may be individual differences in interpretation. This is demonstrated by the many publications that modify and supplement the megatrends originally formulated by Naisbitt, however, without making this language construct methodically manageable (Kreibich 2008). An unambiguous, methodological approach that allows the reliable, transferrable identification and analysis of megatrends has not yet been developed (Popp 2012).

For the purpose of this report, megatrends are defined as long-term transformation processes of the global environment. They are characterised by a broad field of action and major impacts (cf. Z-Punkt 2007), affect all areas of society and mostly have a time frame of about 25 to 30 years (cf. Zukunftsinstitut 2015). Megatrends can be different in different places at different times.

Metatrends and megatrends themselves can be the object of the analysis for a politically exploitable environmental impact analysis of trends, or they can be a descriptive framework for locating trends. However, megatrends do not necessarily have to form the basis of a trend analysis. Examples of "trends in the megatrend" are the increased use of crypto currencies, the exponentially increasing collection of data (big data), new forms of decision-making (artificial intelligence) and the increase in virtual reality in the megatrend of digitisation.

Emerging issues are "newly emerging issues that may have a great significance for environmental policy in the future" (Behrendt et al. 2015: 30). In contrast to megatrends, they are usually described and analysed in much less detail in the research literature; scientific forecasts or scenarios are usually not yet available.

Regarding the Environmental Trend Analysis (ETA) described in detail below, trends will mainly be examined with regard to their environmental impact and made available for environmental policy. In principle, the methodology can also be used to analyse megatrends or emerging issues if trends are concealed behind emerging issues. According to the STEEP system, for example, trends can occur in social, economic, technological, political and environmental areas. The term "trend" can be used to describe, for example, social and technical change processes, developments that change people's attitude to life and consciousness, new ways of living, new production methods, new products or new methods of governance.

The ETA's task is to recognise the influence of trends on environmentally compatible and sustainable development. For this purpose, an analysis must be undertaken of which elements of the environment influence a trend (positive or negative, direct or indirect) and how strong their influence is. Direct environmental impacts are understood in this methods report as those burdens or reliefs that result directly from trend development; indirect environmental impacts are those burdens or reliefs that result only from social or economic changes triggered by the trend. To date, there is no consistent method that can be used to analyse societal, technical, economic or political trends that have no obvious environmental relevance in such a way that the complex, interdependent and often indirect impacts can be systematically recorded and assessed. Through the ETA we would like to make a methodological contribution towards closing this gap.

This methods report is intended to provide a basis for discussion on how to conduct a successful analysis of the environmental impacts of trends. Taking into account the quality and process criteria of futurology, the methodological requirements are (adapted from Gerhold et al. 2015):

- ► replicability of the results;
- ► a transparent approach;
- ► separation of factual and normative decisions;
- ► orientation towards implementation and manageability;
- ► transferability of results and addressee-specific communication;
- ► scientific relevance and integrity;
- ► interdisciplinarity;
- ► naming of all parties involved in the process.

In this sense, the methods report presented is a theoretical basis. In addition, the method presented herein was also applied as a pilot study in the context of the project "Analysis and Evaluation of the Effects of Environmentally Relevant Trends on Environmental Policy Using the Method of Trend Analysis, FKZ 3714 17 102 0" for two trends: the increasing use of 3D printing in industry and society and the change in consumption in the course of digitisation (Consumption 4.0). This methods report also picks up on these experiences.

The paper is addressed primarily to federal and state authorities, funding bodies at federal and state level, research and consulting institutions working on the environmental consequences of socio-cultural, technical and economic trends, but also to similar institutions and bodies at EU level.

The methods report is structured according to the individual steps of the trend environmental analysis. The first step briefly describes how trends can be systematically identified, evaluated and selected (details can be found in the concept study "Horizon Scanning as an Instrument in Environmental Policy for Strategic Early Detection and Efficient Policy Advice, FKZ 3712 11 104"). The second step explains which underlying preliminary explanations must precede the analysis. This includes preliminary operational explanations (e.g. project mandate, budget and time resources), preliminary substantive clarifications (e.g. objectives and object of investigation) as well as preliminary methodological explanations (e.g. environmental categories and indirect search fields). This is followed by guidelines on how to describe trends and how to record the effects of trends. The final step shows how recommendations for action and research can be identified and how the results can be evaluated, presented and transferred.

2 Choice of trends

Trends are assessed as environmentally relevant in various ways. This means they can potentially be used for trend analyses. For example, in a horizon-scanning process, particularly environmentally relevant developments can be recorded. The need for current political action to deal ad hoc and in depth with a forward-looking issue can also give rise to the need to carry out a trend analysis or, perhaps simply, because a topic is the subject of intense public debate.

In Table 1, the emergence of trends, the degree of abstraction and identified trend topics are presented as examples from recently completed or ongoing processes.

Table 1: Examples of trend topics and their genesis

Trend genesis	Source	Degree of abstraction	Trend topics (example)[2]
horizon-scanning process in the Federal Environment Agency	Horizon Scanning 2.0 research project	spatial: regional to global thematic: trends with an impact on nature conservation	• drones • block chain • robotics beyond the industrial warehouse • public and private space travel • accelerated society • …
scientifically guided horizon-scanning prozess based on the Delphi method	Sutherland 2014: “A horizon scan for global conservation issues for 2014”	spatial: regional to global thematic: trends with an impact on nature conservation	• financial markets’ response to the “carbon bubble” • land loss in South East Asia due to the lowering of peatlands • carbon solar cells as an alternative source for renewable energies … •

[2] Translation of the trend themes of Sutherland by the authors of this methods report.

multi-stakeholder research process led by the European Environment Agency	EEA 2015: "SOER 2015 — The European environment — state and outlook 2015"	spatial: global megatrends and subtrends thematic: megatrends and sub-trends, with relevance for EU environmental and sustainability policy, as well as for EU member states	• diverging global trends in demographic development • trend towards a more urban world • changing burden of disease and the risk of pandemics • an increasingly multipolar world • …
synthesis study, with the involvement of external expert opinions, hearings, review procedures, under the leadership of the SRU [German Advisory Council on the Environment]	SRU 2015: Nitrogen: solution report for a pressing environmental problem	spatial: especially related to Germany thematic: presentation of the causes and drivers of nitrogen pollution; inclusion of various trends in relation to these drivers	• increasing spatial concentration of animal production • oversupply of food • decrease in the figures for food consumption data • alienation from food • vegetarian and vegan diets • …
comprehensive, integrated environmental strategy of the BMU	Integrated Environmental Programme 2030	spatial: Germany, but also including the externalisation of environmental impacts thematic: presentation of trends in the field of sustainability transformation (mobility)	• large, heavy, powerful cars • increasing mileage • more freight transport on the roads • …
trends are discussed in the mass media	DER SPIEGEL 8/2017: "Food for thought – a guilty pleasure." What meat? How much meat? Artificial meat	spatial: global thematic: trends in the "artificial meat" sector	• more research into artificial meat (from plants or bioreactors) • …

Source: Own data

Although, trends are effectively selected in different ways for trend analysis, they should ideally be identified as part of a systematic process to prevent distortion effects, such as specific preferences or prior knowledge of the selector. The basis of such a process is the continuous and systematic screening and evaluation of emerging developments. These developments should be evaluated using previously

defined criteria to reach a conclusion about whether the issue should be analysed in depth as part of a trend analysis.

Key criteria for the choice of potential trend topics for the Ministry of the Environment could, for instance, be:

- environmental relevance, i.e. the strength and manner in which a trend affects the environment compared with a reference system;
- news of the topic, i.e. the extent to which the topic has already been dealt with by the Ministry of the Environment and has already been investigated by its research team;
- plausibility of the trend topic, i.e. the extent to which a trend is expected to gain in importance in future.

The basis for the evaluation of trend topics is the cursory analysis of existing research, assessments made by the project team and, if necessary, expert assessments. The evaluation can also be supported by scales in order to ensure that the assessment remains comprehensible. The scales shown in Table 2 can be used for this purpose (and can be supplemented and modified according to the selected criteria):

Table 2: Possible scales for the evaluation of identified trend topics

Dimensions of evaluation	Possible scale
environmental relevance	scale from 1 to 5 (not environmentally relevant to very environmentally relevant)
news value	scale from 1 to 5 (not known to widely known)
plausibility	scale from 1 to 5 (unimportant to very important)

Source: Own data

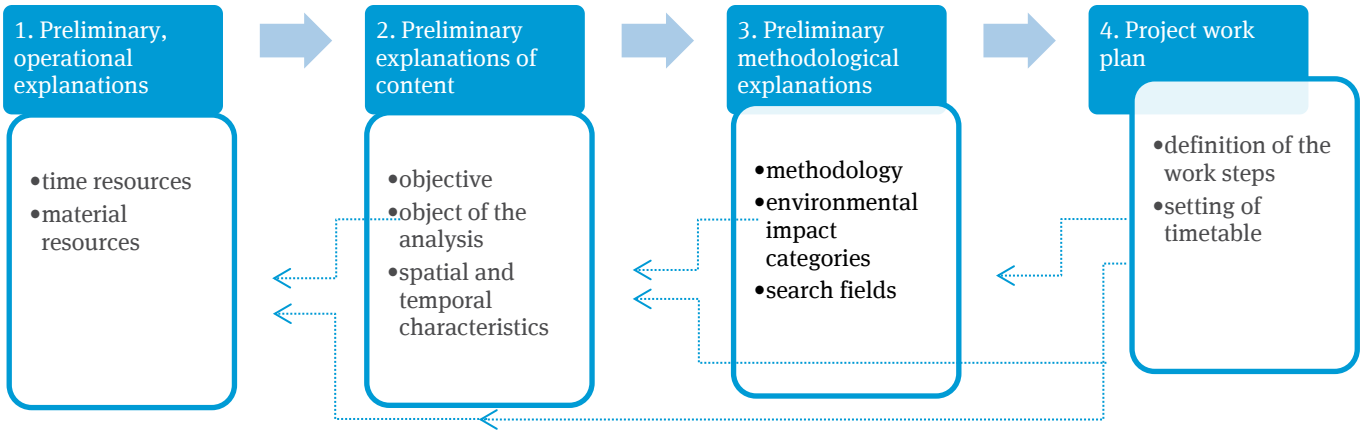
3 Underlying preliminary explanations for an environmental trend analysis

Before starting to analyse a trend, various preliminary explanations need to be made. They represent the first step of an environmental trend analysis. The preliminary explanations are important in order to structure the content of the analysis, to prepare it methodologically and operationally, and to define the objective framework.

Every trend is different. Therefore, before a trend analysis can be carried out, the preliminary explanations of each trend must specifically be clarified beforehand. The main steps in the preliminary explanations process are (see also Figure 2):

- Preliminary operational explanations: which objective and temporal means are available is determined for the trends identified;
- Preliminary explanations of content: based on which resources have been determined, the scope of the investigation is defined (object of investigation; objective);
- Preliminary methodological explanations: depending on the object and objective of the investigation, the methodological details are then established;
- Project work plan: the individual, preliminary explanations are finally combined in an overall work plan.

Figure 2: Ideal-typical preliminary explanation process[3]



Source: Own data

3.1 Preliminary operational explanations

During this work step, certain preliminary, operational explanations are established for the project, thus setting the course for the entire project. The personnel and financial resources must be defined, existing project-relevant preliminary work must be identified and supporting material resources, e.g. software, must be selected and procured. The operational framework conditions can considerably limit the possibilities of the content orientation and complexity of the Environmental Trend Analysis (ETA). Both the available financial and temporal means as well as the existing know-how ultimately determine the quality, content and the time-related feasibility of the ETA. For this reason, it is advisable to develop a comprehensive time and resource plan at an early stage while planning the ETA and determining its content orientation. The clarification of the following questions might form the basis of a time and resource plan:

- What is the project assignment?
- What is the budget available for the execution of the ETA?
- What are the available time resources? What is the expected starting date of the ETA?
- What know-how is available for the implementation of the ETA?
- What personnel capacities are available for the implementation of the ETA?
- Is there any relevant preliminary work available on which the ETA can build?
- Are special technical aids (e.g. measuring instruments, analysis and evaluation software) required for the implementation of the ETA? Are there sufficient technical know-how and personnel capacities available to operate the equipment?
- With which experts and partner institutions, relevant for the ETA, are there established contracts?

The planning of time and resources should not only include the funds needed for implementing the ETA, but also the resources required for the transfer of results. This includes the presentation and publication of the results as well as other activities, such as technical discussions or workshops.

[3] Dotted arrows indicate feedback loops.

Sufficient resources need to be provided for, especially if the results, or at least part of them, are also directed to the political arena or the public.

The formulated time and resource plans will then provide the basis for subsequently developing more detailed plans. They also provide information on the subsequent allocation of tasks and responsibilities.

3.2 Preliminary explanation of content

In this step it is necessary to sharpen the project orientation and content. Firstly, the objectives and addressees of the trend analysis must be recorded (see 3.2.1). Secondly, the object of the analysis must be specified (see 3.2.2). This also involves limiting the geographical and temporal scope of the analysis (see 3.3.3).

3.2.1 Objective of the analysis

In terms of the content, the first step in the ETA is to formulate which goals need to be achieved within the scope of the analysis and – linked to this – to define the target group to which the investigation is directed. The objectives and the definition of the target group determine the focus of the analysis and the further structuring of the content. The following questions must be clarified in this context:

- Who are the planned users of the study and what are their expectations and intentions?
- Should scientific goals be achieved?
- In addition to the primary objective, are there specific secondary objectives?
- How should the results be published? Do further activities need to be planned for the transfer of results[4]?
- Are there any methodological or technical information gaps that need to be filled?
- Should a trend be analysed in depth, or should there be an extensive presentation of the sub-topics instead?
- Will only one trend be evaluated or should several trends be compared?

3.2.2 Object of the analysis

Once the objectives of the analysis have been formulated and a target audience has been established, the object of the analysis should be broadly distinguished and defined. Based on previous knowledge of the trend, it is defined as precisely as possible and its boundaries are established. As a general rule of thumb, the more specifically a trend is differentiated, for example to only one technological field of application, the more precisely an analysis can be carried out. This step can also be supported by individual methodological steps (cf. Cook et al. 2014), for example by systematically reviewing scientific abstracts on the trend topic, so that central aspects of a topic can be more precisely recorded. Leading questions in this context are:

- What is already known about the trend? Are there gaps in knowledge?
- Is the trend easy to narrow down or still difficult to grasp?
- How is the trend defined by academics and scientists, and in public discussions?

3.2.3 Definition of the spatial and temporal scope of the analysis

Trends can be described within different ranges. These include, in particular, the geographical and temporal components that can determine the nature of a trend. The aim of determining the geographical and temporal reach of a trend for the analysis is also to define the complexity of the

[4] The transfer of results can only be planned in detail once the results of the analysis are available. However, resources for the transfer of results should already be budgeted for and a rough time plan for the transfer be in place.

analysis. Concrete geographical spaces and time periods are thereby defined for which the manifestation of the trend is examined in the ETA. The definition makes it possible to work out potential trend developments for specific geographical areas and time frames. This can help to reduce the uncertainty of complex trends.

Questions which could define the geographical and temporal scope are:

► Has a local (e.g. cities, municipalities), regional (e.g. federal states), national (states), international (e.g. EU, OECD, Central America) or global perspective been adopted? Or does another geographical unit, e.g. a natural environment, form the basis of the study?

► Should the short (e.g. up to 5 years), medium (e.g. up to 10 years) or long-term (e.g. from 10 years onwards) perspective of the trend be recorded?

► Is the investigation based on precise or roughly defined periods of time?

3.3 Preliminary methodological explanations

Trend analyses are available for many different purposes and objectives. In industry, trade and marketing, trend analyses are used, for example, to examine future markets, the sales potential of products and new business areas. By contrast, the environmental trend analysis described herein aims to systematically analyse trends with regard to their potential effects on the environment. For this purpose, certain preliminary, methodological explanations must be made, particularly concerning the step "Survey of the environmental impacts of trends" (see Chapter 5). First, the methodological approach to describing the trend, to assessing environmental impacts and to developing recommendations for action and research must be clarified. Second, the various environmental impacts to be considered must be determined before the trend analysis can begin. This requires a systematic overview of all possibilities of burdening or benefitting the environment (see 3.3.2). Finally, a systematic approach is needed to identify the indirect effects of trends (see 3.3.3).

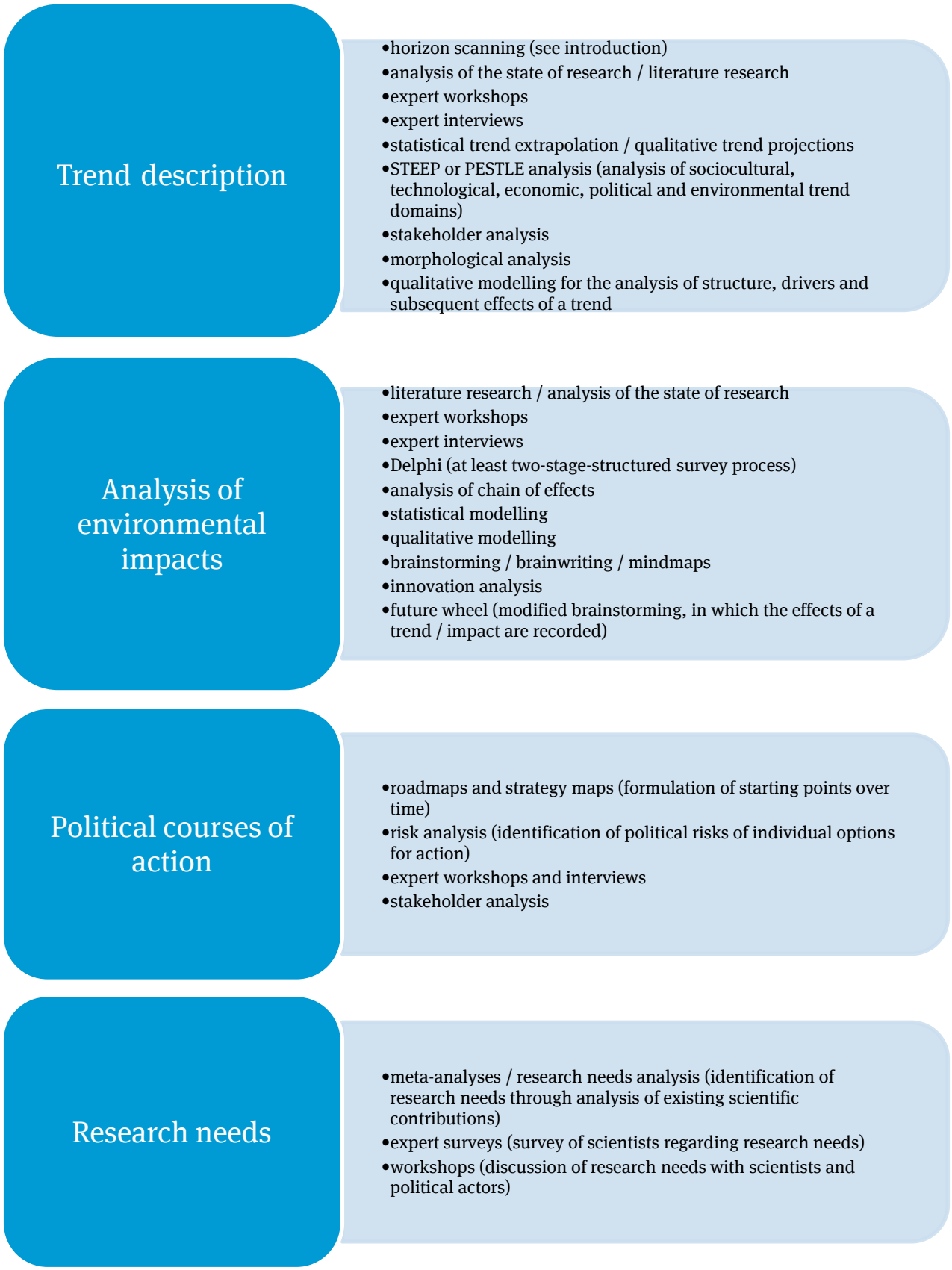
3.3.1 Selection of method(s) for describing trends, for assessing the environmental impact of trends and for making recommendations for action and research

In principle, there are various ways of determining the effects of trends, e.g. on the environment, on a specific (environmental) policy field or on another research objective, and of deriving recommendations for action and research. Figure 3 presents various methods that can be applied in the individual phases of a trend analysis.[5]

Within the scope of the methodological preliminary explanation, it must be determined which method or which method mix is selected for determining the environmental impacts and action and research recommendations. If, for example, the influence of stakeholders on a trend or trend development is to be recorded as well as, ultimately, on the environment, then performing a stakeholder analysis is a good option. If time series data are available on the trend, this can be statistically extrapolated to provide an understanding of the future development of a trend. In addition to selecting the methods, it should also be determined whether several methods could be combined for individual steps in order to improve the quality of the results (e.g. the combination of literature research, expert surveys or surveys). The question of timing must also be clarified, i.e. the sequence in which the individual methods are used.

[5] The list is not to be regarded as final.

Figure 3: Methods box for trend analysis



Source: Own data and Cook et al. 2014

Within the scope of the research project in which this methods report was developed, two trend analyses on 3D printing and Consumption 4.0 were prepared as described above. For this purpose, the analysis of the state of research and literature, trend projections, horizon scanning, workshops, an analysis of the chain of effects, and a method developed specifically for this project for recording the effects of the innovation potential of a trend (hereinafter referred to as the IIC method) were used. The combination of methods used is described in more detail in Chapters 4 and 5.

3.3.2 Determining the objects of protection and environmental burdens under consideration

In addition to selecting the methods for the trend analysis, it is necessary to determine which negative and positive environmental impacts should be considered more thoroughly during the analysis in order to be able to systematically determine their environmental impact. Usually, protected (natural) resources, which – in a first approximation – can be determined as water, soil, air, atmosphere and biosphere, are taken into be consideration. For a trend analysis, as presented in this methods report, the Federal Environment Agency's category system VERUM is used. This tries to offer a simplified but nevertheless complete system of possible environmental impacts in order to systematically assess the environmental impact of products and services during their life cycle – in the case of the originally intended use of the associated study. The environmental trend analysis should also systematically identify and analyse environmental impacts during the trend in a manageable manner. By using the VERUM category system, a certain standardisation, and thus comparability is possible, both of trend analyses and other studies, which the VERUM system is based on, and of trend studies among themselves.

VERUM 2.0 defines five general types and 19 specific categories of burden (see Table 3). Ideally, trends are analysed multidimensionally, including all VERUM categories. The limitation to certain environmental categories to be analysed can become meaningful if, from the outset, the focus of the ETA is on a certain environmental category and not on the systematic recording of all possible environmental impacts. From the preceding points and, in particular from the objectives of the ETA and the targeted addressees, there may be such indications for environmental categories to be analysed that should be in ETA's special focus of interest.

Table 3: Types and categories of burdens in VERUM 2.0

Types of burden	Categories of burden
chemical	greenhouse gases
	air pollutants
	indoor pollutants
	waste water
	diffuse nutrient and pollutants deposited into water and soil
physical	noise
	radiation
	mechanical killing of animals
biological	microbial loads
	invaders
use of resources	consumption of mineral resources, including fossil fuels
	consumption of biotic resources

Types of burden	Categories of burden
	water consumption
	land use
other	incidents/accidents
	landscape aesthetics
	smell
	tangible goods

Source: UBA 2017

3.3.3 Preliminary explanations for the assessment of indirect environmental impacts

Trends can be responsible for the long-term restructuring of societies and economies, which, in turn, can have indirect effects on the environment. New technologies and production processes change old industrial processes, new industries emerge, old ones disappear from the market. Innovations in communication create new forms of social interaction and influence people's attitudes. Effects can also be seen in the creation of economic systems and affect the forms of economic activity itself and social interaction among economic subjects. New forms of production and services affect the relationships between employees and employers, suppliers and clients, and forms of ownership. Fixed role models can therefore be dissolved or at least changed by trends.

These social changes have an indirect effect through "social metabolism", i.e. through the "material and energetic exchange relations between society and its natural environment" (Gingrich and Krausmann 2008: 7). The indirect effects of a trend are often not clearly discernible, since it is seldom a single trend that works alone, but rather several processes of change taking place in parallel and causing their respective effects. In addition, indirect environmental impacts, by definition, arise only at the end of long causal chains, with many intermediate steps, which in turn can be influenced by a variety of factors that are often difficult to determine within the framework of an analysis. Thus, the identified indirect environmental impacts of a trend are usually associated with high uncertainties as to whether the indirect environmental impact will actually occur and with what intensity.

A two-stage procedure tested in the research project can be used to identify societal changes despite the challenges mentioned, to assess their relevance and to classify those changes in terms of their environmental impacts (see Chapter 5). For this purpose, the first step is to analyse which social changes can plausibly be triggered, strengthened and influenced by the trend. Secondly, it is examined how these changes could in turn have an impact on the environment. For the identification of social changes, it makes sense to define indirect search fields in advance. Important questions to be asked in this context, for instance, are to what extent the trend gives rise to greater efficiency, which additional resources are released, whether other activities/services are substituted by a trend or whether a trend even leads to sufficiency, i.e. whether certain activities/services become obsolete.

The search fields for the identification of socially affected areas are fed by categories used in horizon scanning processes, multi-stakeholder processes for the analysis of global environmental changes, in environmental sociology, environmental psychology, and political science. Included were i) STEEP, DEGEST and Cranfield classifications (Morrison 1992; Bengston 2013; CERF 2012), ii) Global Environmental Outlook 5 (UNEP 2012), Millennium Ecosystem Assessment (2005), SOER 2015 (EEA 2015), iii) Environmental sociology, environmental psychology and political science classifications (Huber 2011; Kollmuss and Agyeman 2002; Oskamp and Schultz 2005; Hague and Harrop 2016).

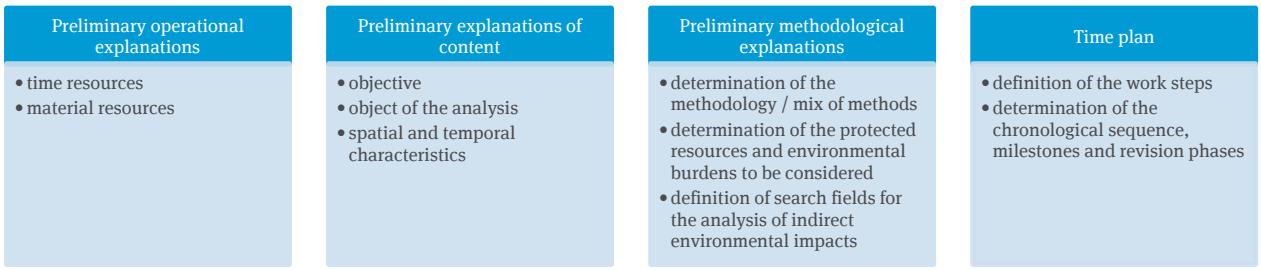
The search fields considered include demography (e.g. age distribution and migration) and health (e.g. health care), space (e.g. settlement and infrastructure development), economy (e.g. economics, science

and technology (e.g. technological innovations), politics (e.g. political participation) and society and culture (e.g. environmental awareness).

3.4 Project work plan

At the end of the preliminary explanation, a project plan is developed which brings together the operational, content and methodological preliminary clarifications and guides the analysis. The project plan also includes a timetable for the individual methodological steps. Figure 4 shows a possible structure of the project work plan.

Figure 4: Possible structure of the project work plan



Source: Own data

4 Method for describing trends

Based on the operational, content and methodological preliminary explanations, the task now is to describe the trend with this work step. A comprehensive and detailed description of a trend forms the basic framework for further action and must therefore be carefully prepared and, as far as possible, provide an overview of all data, facts and forecasts (as quantitative as possible, otherwise qualitative). The better one understands the background, driving forces and "anatomy" of a trend, the more precisely it can later be evaluated in terms of its environmental implications. It is important that a trend description covers all those aspects of a trend that could potentially be related to the (direct and indirect) environmental impacts in a well-structured and clear manner. A more detailed trend description thus serves, on the one hand, to gain a deeper understanding of a trend. On the other hand, it serves as a basis for past, present and possibly future surveys of the environmental impacts of a trend.

4.1 Flowchart for carrying out a trend description

An in-depth description of the trend consists of three consecutive steps: the identification of the key factors of the trend ('anatomy of the trend'), the characterisation of the trend on the basis of these key factors up to the present time and the estimation of the future development of the trend. The ideal-typical sequence of the trend description is shown in Figure 5 below. The individual analysis steps are described in detail below and examples are given.

Figure 5: Ideal-typical way of describing trends

Source: Own data

4.2 The individual analytical steps

4.2.1 Identification of the key factors of a trend ("anatomy of the trend")

In the first step of the trend description, it is necessary to record the essential key factors of the trend ("anatomy of the trend"). The main objective of the trend analysis (see Chapter 1, Background) is to identify the "nature, causes, developmental speeds" of the trend (Cornish 2005: 78).

The exact focus of the description (and thus also the key factors to be chosen) always depends on the interest in gaining insights and also on the area from which a trend originates (whether it is, for example, a development in a cultural, economic, technological or political, etc. area). Irrespective of this, however, general key factors can be identified which may form the basis for any trend description.

In any case, those actors should be identified who are significantly involved in the trend, i.e. who influence it and/or are affected by it. Here, it is particularly important to record which past and present potential the actor has in order to change the strength and direction of the trend, or how strongly they are affected by the trend. Only those actors should be included who are particularly important for understanding the trend. The spatial and temporal characteristics of the trend should also be recorded. This includes the spatial distribution on the international, regional, national, sub-national scale as well as the beginning and course of the trend (depending on the definition of the object of investigation, see Chapter 3.2.2). Effects on the status quo should also be described, i.e. the magnitude to which the trend has changed the current state.

Finally, the context of the trend must be outlined, i.e. whether and how the trend is related to other trends and developments. One example is the European Environment Agency's mega-trend system (EEA 2015 and EEA 2017; see Table 4). The megatrends recorded here include "diverging global trends in world population", "trend towards a more urban world", "changing pressures from diseases and the threat of pandemics" and "accelerated technological changes" (further megatrends can be found in EEA 2015; translation by Behrendt et al. 2015). The context of the trend also includes how the trend is currently being discussed in the media and in society.

In addition to the actors and context of the trend, the "definition of the object of investigation" (Chapter 3.2.2) should again be used, further complemented and specified by additional characteristic key factors of the trend. As a result, the trend description should show completely and vividly what the trend is about. In Table 4, all selected key factors for the trend description of 3D printing are presented as examples. The additionally selected key factors are shown in italics in the table.

Table 4: Selected key factors for the pilot-like trend description of 3D printing (the additionally selected key factors are in italics)

3D printing	Brief description of the characteristic
context of 3D printing	classification of 3D printing in social developments
development of a 3D print (temporal and spatial characteristics)	representation of the development of 3D printing over time (start of use in industry and in the desktop area; changes in the status quo) and spatial "expansion" of 3-print use
process chain, method and materials involved in 3D printing	*presentation of the different technologies used, the materials used and the production process*
3D printing market	*presentation of sales of 3D printing products (3D printers; materials; accessories; software; services; etc.)*
key actors	presentation of the industrial players, professional profiles, industry-related use of 3D printing
fields of application	*representation of the different fields of application of 3D printing (industrial, private, experimental as well as which products and objects are manufactured)*

Source: Own data

4.2.2 Characterisation of a trend based on predetermined key factors

After defining the key factors to be examined, the actual trend description is carried out. For the respective key factors of the trend, relevant scientific literature and research reports are investigated and processed with literature research, as well as data (time series if available), research and development projects and further information via further research. This research can be further complemented by expert interviews or expert workshops to fill information gaps. The trend description only takes place for the previously defined spatial and temporal range (Chapter 3.2.3).

4.2.3 Estimation of the future development of a trend

In the last step of the trend description, the future development of the trend is estimated. The starting point for the estimation is the assumption that future developments are "a continuation of the past", as described in the introduction (Duinker and Greig 2007: 209). In addition, it is assumed that the future development of a trend depends on key factors that can be identified by analysing the past development of a trend.[6] For this work step this results in the estimation of the future development of the trend being based closely on the previous trend description.

In principle, two methodological approaches can be distinguished for estimating the future development of a trend. With the methodologically simpler approach, available estimates of previous trend dynamics, trend projections / forecasts (e.g. market forecasts), estimates of the future course of a trend and possible countertrends (e.g. in trend reports; via web mining[7]), scenarios that have

[6] Simultaneously, one should bear in mind that, parallel to the processes driving the trend, there also are processes which counteract the current trend development.

[7] Web mining is defined as the "application of data mining techniques on the World Wide Web" (Cooley et al. 1997: 558). Data mining, by contrast, comprises the "discovery of interesting, unexpected or valuable structures in large datasets" (Hand 2012: 621).

already been developed as a trend scenario, and time series data on a trend or important trend aspects that which have been extrapolated are investigated within the scope of a literature search. If such forecasts, estimates and time series data on the trend are not available, then the future development path of the trend can alternatively be estimated via a separate process in which a trend scenario is developed. This methodological approach (the so-called "intuitive logics" method of scenario development founded by Royal Dutch Shell; Duinker and Greig 2010: 2010) is similar to studying the development of scenarios, except that it focuses only on one scenario, namely the continuation of a trend.

For the second, methodologically more demanding approach – of analysing the development of one scenario – various analytical steps must be carried out. Firstly, the sphere of influence must be defined, i.e. the area in which the factors of influence act. In the case of this trend analysis, the object of the analysis has already been defined in Chapter 3.2.2 ("the trend"). Secondly, the most important key factors that most strongly influence the dynamics of the trend development to date must then be identified. A distinction can be made between internal and external key factors. The internal key factors include the actors already described above, and also other characteristics such as procedures and fields of application. External key factors lie within the sphere of the trend and have an effect on it. They include all those factors that have a promoting or inhibiting effect on the trend, but are not necessarily characteristic of it, though they may also affect other aspects of it. The classification of the external key factors follows the STEEP grid, i.e. different key factors are assigned to five fields: Factors can be social (Social), technical (Technology), economic (Economy), ecological (Ecology) or political (Politics) nature. The classification serves to reduce complexity when considering a large number of possible key factors (Fink, Schlake & Siebe, 2002). The third step involves identifying indicators for the key factors in order to make assumptions on how likely they are to develop in future (e.g. increase or decrease). Where possible, scientific literature or expert appraisals are used to further develop the indicators. As a final step, the trend's progression is estimated. To this end, an assessment is made of how the trend might develop further under the influence of the key factors.

5 Method for measuring the environmental impacts on trends

After describing the trend comes the core of the ETA: the survey of the direct and indirect, positive and negative environmental impacts of trends. In this methods report, direct environmental impacts are understood to be those environmental burdens or reliefs that result directly from the trend – temporally and spatially – without any social or economic intermediate steps. Indirect environmental impacts are understood to be those burdens or reliefs which only result from influencing or triggering changes outside the trend, e.g. social or economic changes.

Two methods were used in this project to determine the environmental impacts, which are described in more detail here: impact assessment and the IIC method. Both differ: while impact assessment is primarily oriented (causally and analytically) towards the short and medium-term future and gathers data on the (direct and indirect) effects of the trend on the environment, the IIC method is a creative procedure which takes a visionary perspective, focusing on the innovative aspects of a trend and reflecting on which environmental impacts these innovative aspects might bring with them if they were contemplated further into the distant future. In this project, both methods were combined to cover a wide range of potential short, medium and long-term environmental impacts in the environmental assessment.

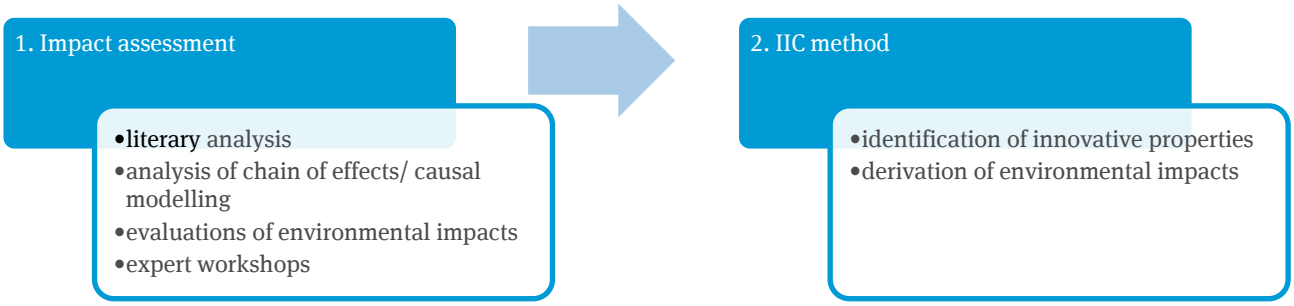
At the heart of the IIC method is the explorative investigation of the environmental impacts of the trend. The procedure is based on the insight within futurology that the purely causal analysis of trends (which impact assessment is based on) should be supplemented by other methodological approaches in order to obtain a more comprehensive picture of possible future developments (Milojević and Inayatullah

2015). In this context, research will discuss i) the role of narratives and literary presentation in the illustration and communication of visions of the future (Burnam-Fink 2015; Bina et al. 2017; Miles 1993), ii) the role of inductive approaches, intuition and exploration for the description of possible futures (Schirrmeister and Warnke 2013; Bowman et al. 2013; Wright et al. 2013; Iden 2017) and iii) the use of creativity techniques in strategic futurology (Cachia et al. 2007). The methodology referred to here as the IIC method picks up on these impulses.

5.1 Flowchart for determining the environmental impact of trends

There are six steps to assessing the environmental impacts of trends. As part of the impact assessment, a literary analysis and a (qualitative) impact analysis[8] are carried out in order to identify and evaluate the environmental impacts. In this paper we present two different methodological variants: chains of effects and causal modelling (CLD). The environmental impacts determined in one of the two methods are then validated at an expert workshop. Within the creative IIC procedure, innovative characteristics of the trend are identified and environmental implications are derived. The ideal-typical process of the environmental impact assessment is shown in Figure 6 below and the individual analytical steps are described in detail below.

Figure 6: Ideal-typical method of assessing environmental impacts



Source: Own data

5.2 Impact assessment: Recording the direct and indirect environmental impacts of a trend

5.2.1 Literary analysis

The first step involves carrying out a systematic literary analysis and processing the current state of research and discussion on already documented direct and indirect environmental impacts (pressures & impacts on the state of the environment in the DPSIR model). The research is carried out by means of German and English search terms and keywords derived from the trend description and compiled by the project team. Among other things, scientific literature, research reports and "grey literature" are included. In addition, relevant research and innovation databases are evaluated according to recently completed and still ongoing projects or innovative developments.

5.2.2 Analysis of chain of effects (Variant I)

The second methodological step involves carrying out an analysis of the chain of effects to systematically record further direct and indirect burdens and reliefs for the environment in order to obtain a complete overall picture. Effect chains are a heuristic (a scientific tool) to reduce complex social phenomena to (causally) particularly important effects. The reason for using the analysis of the chain of effects is that for many trends there is still no broad, scientifically-based survey of

[8] Alternatively, chains of effect or causal modelling (CLD)

environmental impacts and therefore a procedure must be used that systematically identifies possible impacts. It is important to note that the primary aim of this step is not to visualise the chains of effects (i.e. to present them as chains) but, above all, to systematically analyse them (as a background for the study). For this reason, at least to begin with, we do not consider it necessary to provide complex graphic illustrations of the chains during the analysis. This could be done at the end of the project if a visualisation of the results is considered useful.

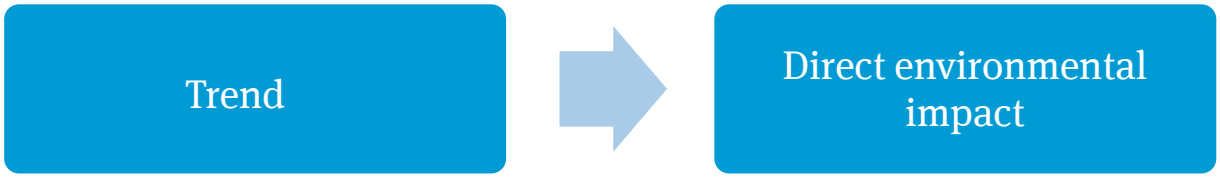
Empirical social research generally distinguishes between independent and dependent variables, which together form a chain of effects. Independent variables cause changes in the dependent variable, for example changes in economic development (independent variable) can affect resource consumption (dependent variable). In addition, there are intervening variables that represent the link in the causal chain between independent and dependent variables – for this example, these would include changes in income (cf. UFOPLAN project Income and Resources – Effects of Changed Income on Resource Consumption; FKZ 3714 93 104 0). Effect chains can become very extensive depending on the vested interests involved, especially if many intervening variables are decisive and feedback effects occur. Figure 7 illustrates the general structure of chains of effects.

Figure 7: Simple model of a chain of effects

Source: Own data

This model of impacts is then transferred to the analysis of *environmental* effects of trends. A distinction must be made between direct and indirect environmental impacts. For both these areas, conclusions are drawn from the trend description and the previously established areas of possible negative environmental impacts (VERUM 2.0) are used (see Chapter 3.3.2). The trend forms the starting point of the chain of effects, while the environmental impact categories form the end point. With regard to the direct environmental effects, we examined whether and which environmental impacts might be triggered with the individual key factors of the characterized trend. In addition, the mechanism by which these impacts could occur was recorded. Figure 8 illustrates the chains of effects that were created.

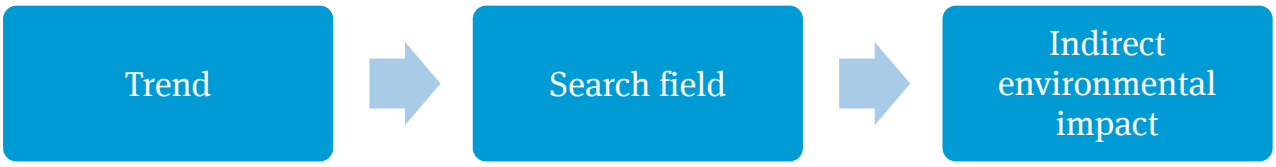
Figure 8: Direct environmental impacts of a trend



Source: Own data

With regard to the indirect effects, first a complementary analysis is conducted of those search fields which might be affected by the trend (see Chapter 3.3.3) and the extent to which changes in these search fields could trigger effects on the environment. For this reason, the search fields are temporarily stored in the chain of effects. Figure 9 shows the chains of effects generated in this way.

Figure 9: Indirect environmental impacts of a trend



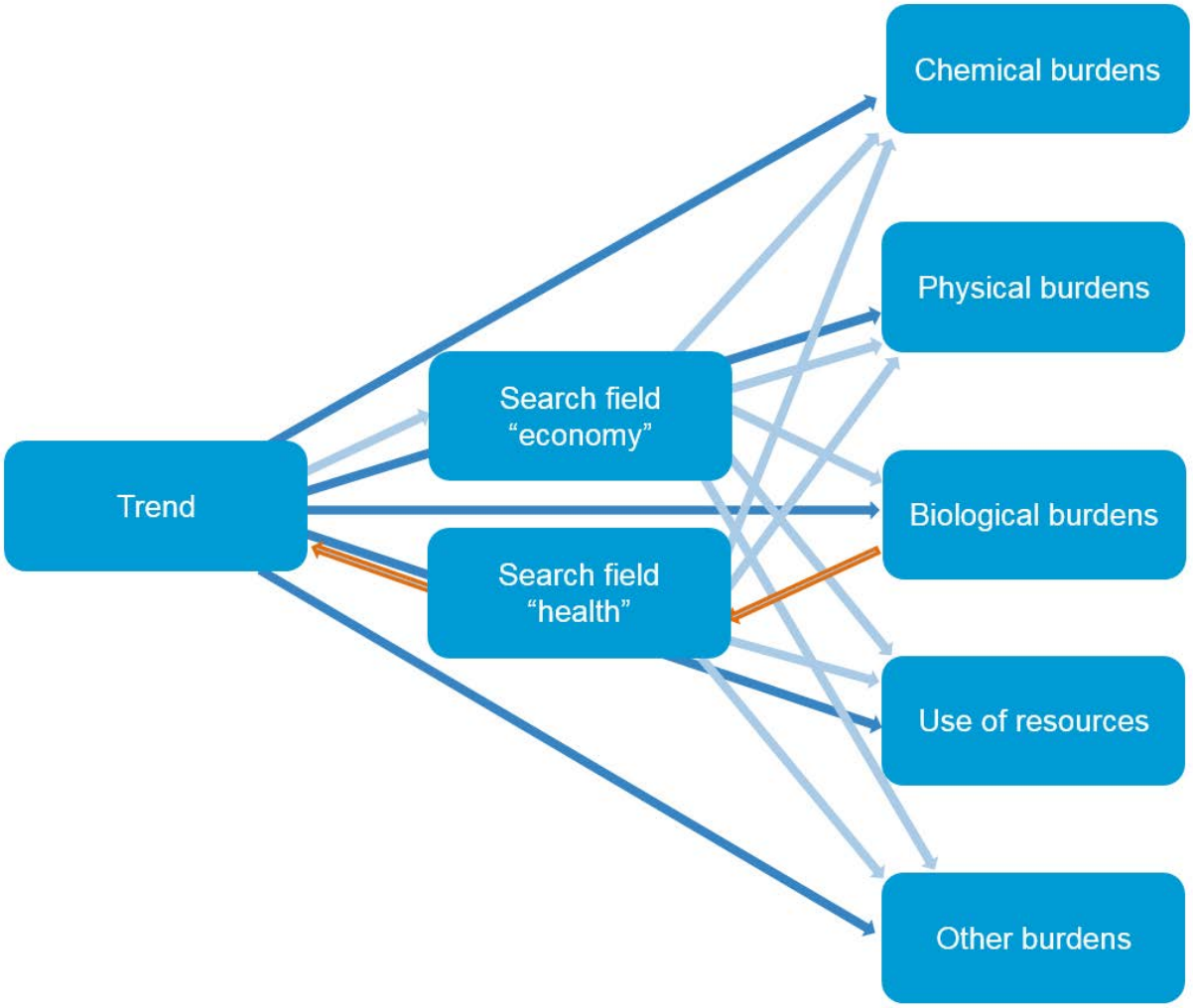
Source: Own data

5.2.3 Causal modelling (CLD) (Variant II)

Causal modelling is a second variant that can be used to systematically assess environmental impacts. This requires a corresponding software solution, e.g. software for the development of system dynamic models or special applications for qualitative modelling. In contrast to the chains of effects described above, the software not only enables one to describe linear relationships – from the trend to the direct effect or from the trend via a search field to the indirect effect – but also to record all causal links and thus central feedback loops in a system. The creation process usually takes place directly in the software, which prepares the cause-and-effect relationships in a graphically understandable way, so that participative-discursive work can be carried out.

In trend analysis, qualitative models can be used "descriptively" or "exploratively". Descriptive models represent a visualisation and analysis of already known relationships, e.g. to present the results of the literary analysis (see chapter 5.2.1). This model is then supplemented exploratively. With systematic questions, the model is extended by means of previously unknown correlations. For this purpose, analogous to the procedure of the chains of effects described above – each key factor is examined to ascertain whether a direct effect is conceivable, e.g. of key factor 1 on environmental category 1, of key factor 1 on environmental category 2, etc. – and whether an indirect effect relationship via the search fields is conceivable. However, in addition to the chains of effects, further factors can be addressed, e.g. on what does it depend that a certain effect relationship takes place. All results are transferred directly to the model and thus displayed visually. The (partially automated) model evaluation (analysis of feedback loops, evaluation of ambivalent/competing impact paths, etc.) then provides information not only about the linear effects, but also about effects that will intensify or weaken in future, central drivers as causes of one or more environmental problems, starting points for the exploitation of opportunities, etc. The model evaluation thus already provides argumentation lines to facilitate the assessment of the identified impacts in Chapter 5.2.4.

Figure 10: Simplified scheme for a qualitative cause-effect model.



Source: Own data

5.2.4 Evaluation of identified impacts

Following their identification, the environmental impacts are assessed. The aim of this step is to reflect once again on which environmental effects are to be given special consideration in environmental policy and to sift out less relevant or irrelevant effects. If possible, the evaluation should be carried out within a multi-member team and be guided by evaluation criteria that fit in with the previously formulated objective of the trend analysis (see Chapter 3.2). For the Ministry of the Environment it is useful to assess the identified impacts with regard to their evidence base (for the literary analysis) or plausibility (for the analysis of the chain of effects) as well as their strength. If necessary, further criteria can be included (depending on which interests are involved, see Chapter 3.2), for example a comparison of the environmental impacts with other trends or currently dominant developments (status quo comparison).

The assessment of plausibility can be made by analogy, i.e. the probability of an effect occurring can be analysed on the basis of existing knowledge, since the phenomenon being analysed is comparable to a phenomenon that has already been studied in more depth and it does not contradict the existing research findings. The plausibility must be comprehensible to all members of the research team, i.e. the evaluation should be the result of a group decision in the research team.

Based on the evaluation of the robustness, plausibility and strength of the effects, these can ultimately be prioritised for environmental policy. In the case of qualitative modelling and software-supported evaluation, there is automatically a ranking of the trends with regard to their potential impact strength, whose plausibility should nevertheless be verified by the team.

5.2.5 Expert workshop(s)

Following the identification and assessment of the potential environmental impacts of the trend, one or more workshops with experts should be held to discuss, specify, complement and obtain stakeholder views on the results and to formulate initial approaches for (environmental) policy work on the issue. The workshop(s) can also be used to present the results of the IIC procedure for discussion (see Chapter 5.3). The central impacts can also be selected. Expert knowledge should be used for those aspects of the analysis for which there are still insufficient research results or which are subject to a qualitative assessment by the project team and thus support decisions (Drescher et al. 2013).

If a one-day expert workshop is held, the trend description can be briefly outlined again in the first part of the workshop and then be debated by the participants. The possible environmental impacts can then be presented and critically discussed (based on the impact assessment and the IIC method). In a concluding round of discussions, the participants can then work out political approaches. The development of the starting points can also take place in small thematic groups in order to develop more targeted recommendations.

If two one-day expert workshops are held, the first workshop can deal, for example, with the results of the trend description, the impact assessment and the IIC procedure. In the second workshop, the political approaches can be discussed. The first political starting points can also be researched in advance by the project team and linked to current political processes and starting situations such as existing legal requirements.

The selection of experts is important. As far as possible, different stakeholders with divergent interests / opinions on trend development and the associated (environmental) consequences should be invited. Important stakeholder groups basically include scientists, politicians, civil society and industry representatives. The exact composition should be adapted to the thematic orientation of the trend analysis. In preparation for the workshop, the experts will ideally be sent the current results in a form that is as concise as possible.

5.3 IIC method

In the first step, the IIC method focuses on identifying and analysing the innovation potential of the trend, i.e. the ability to radically redesign existing conditions. In the second step, the focus is on deriving the environmental impacts associated with this innovation potential. The focus on innovation is justified by the central role of innovation systems as drivers of social and economic developments (Blättel-Mink and Menez 2015).

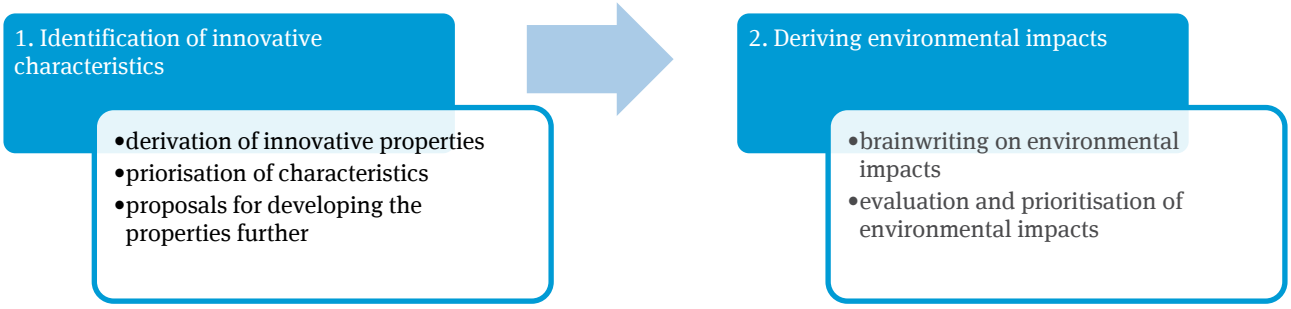
The process requires thinking “outside the box”. The following processing instructions must be observed:

- **Think openly, don't stick to the now**: It is not the task of the IIC method to systematically grasp phenomena that can already be observed. Rather, it intends to go beyond what can be observed.
- **Continue already emerging developments**: Emerging developments should not be ignored, but should be contemplated more boldly. For example, in 3D printing it is already possible to realize more complex geometries. The process calls for thinking ahead and imagining a world in which very complex component geometries have become standard.

- **Courage to take risks**: It is crucial to accept the risk of an "unrealistic" future. When carrying out the trend analysis, it is particularly important not to limit oneself from the outset to a future that now seems plausible, but rather to remain open to other possibilities for the future.
- **Staying transparent, displaying uncertainties**: The nature of the procedure opens up the view to beyond what can currently be observed. At the same time, from a scientific point of view, comprehensive uncertainties are associated with it, which must be displayed transparently.
- **Creativity instead of literary evaluation**: Care should be taken to avoid merely resorting to the use of a literary evaluation for the method. Instead, creativity should take centre-stage.

The ideal-typical sequence of the IIC method is shown in Figure 11.

Figure 11: Ideal-typical sequence of the IIC method



Source: Own data

5.3.1 Identification and analysis of innovative characteristics, assumptions on their development and the development of future scenarios

Innovations are understood in this methods report as "fundamental innovations (...) or improvements of processes or structures" (Blättel-Mink and Menez 2015: 35). These are new in the radical sense of "being in the world for the first time" or they are new to the system that introduces this innovation (Blättel-Mink and Menez 2015: 35).

In order to capture the innovation potential of a trend, the first step is to identify the innovative characteristics of the trend (i.e. that which makes the trend truly innovative and distinguishes it from other developments). The central source for this is the trend description, in which special characteristics of the trend have already been developed. The results of the first step should first be collected and transformed into a worklist of innovative characteristics.

In the next step, the data gathered in this way are evaluated and prioritised in order to identify only the most important innovative ones. Only those characteristics should be selected which, in the project team's opinion, did not yet exist or are new to the field in which they are used (meaning they are "innovative"). Furthermore, the characteristics should be "capable of development" (e.g. they should be able to be improved and not be permanent).

Subsequently, assumptions are made about the further development of these selected characteristics. It is assumed that the innovative characteristics will fully develop. It is also possible to take a creative approach to the innovative characteristics, addressing other aspects that are conceivable. This creates an "innovative future scenario" for the trend, in each case for the selected innovative characteristic. In order not to complicate the analysis, such future visions should only be collected for the most important aspects.

Table 5 shows examples of innovative characteristics and assumptions about their development for the trend 3D printing and Consumption 4.0 examined in the project.

Table 5: Innovative features and assumptions about their development for the trend of increasing use of 3D printing

Trend	Innovative property	Assumption	Future scenario
3D printing	flexible production sites	complete development of the innovative characteristic: completely flexible production site	In future, it will be possible to produce 3D objects anywhere in the world.
Consumption 4.0	The consumer is relieved of all tasks associated with the purchase.	Purchases will be shifted to consumer agents.	In future, consumer agents will shop for the consumers, and consumers will only use the goods they have bought.
…	…	…	…

Source: Own data

5.3.2. **Identifying environmental impacts**

In the next step, the future scenarios are analysed with regard to their environmental effects. The creative technique of brainwriting is used to support the process (cf. Heslin 2009). Brainwriting is an enhancement of brainstorming (Popper 2008). In the first step of brainwriting, concepts and ideas are quietly noted down within the group without any discussion taking place (silent). This is thought to reduce various distortions that might occur as a result of the brainstorming method (e.g. different hierarchies within the group) (Heslin 2009).

For each previously developed scenario of the future, each member of the project team individually writes down how this scenario of the future relates to the environment (possible impact paths), which positive or negative effects can be imagined within this scenario of the future. The individually created impacts are collected by the project manager and then evaluated individually by the project team. The team assesses whether the environmental impacts have not yet been covered by the impact assessment. They also assess whether the impacts are (particularly) interesting from an environmental point of view (e.g. due to their strength, irreversibility, connection with environmental policy processes, etc.). The evaluation results are then compiled by the project manager and the environmental impacts that best meet the defined criteria are selected. If the evaluation is not clear, the results are passed back to the team; the team can then reconsider its evaluation and adjust responses if necessary. Table 6 shows examples of the environmental impacts on two future scenarios.

The environmental impacts identified in this way should then be discussed again in an expert workshop and the most important impacts be prioritised. The expert workshop mentioned above under 5.2.5 can be used for this purpose (see illustration above).

Table 6: Future scenarios and implications for the environment

Trend	Future scenario	Environmental impact	Recording of impact assessment	Relationship to environmental policy
3D printing	In future, it will be possible to produce 3D objects anywhere in the world.	impact on the control of supply chain standards	undocumented	environmentally relevant (sustainable supply chain management; externalisation of environmental impacts)
Consumption 4.0	In future, consumer agents will shop for the consumers, and consumers will only use the goods they have bought.	As contacts, consumers will be weakened and consumer agents will be strengthened.	undocumented	relevant for environmental policy (sustainable consumption)
…	…	…	…	…

Source: Own data

6 Recommendations for action and research

In the final step of the analysis, recommendations for action and research are developed. The aim of this is to translate the previously developed assessments into concrete, political and scientific starting points. Different approaches can be used for this purpose, as shown in Figure 12.[9]

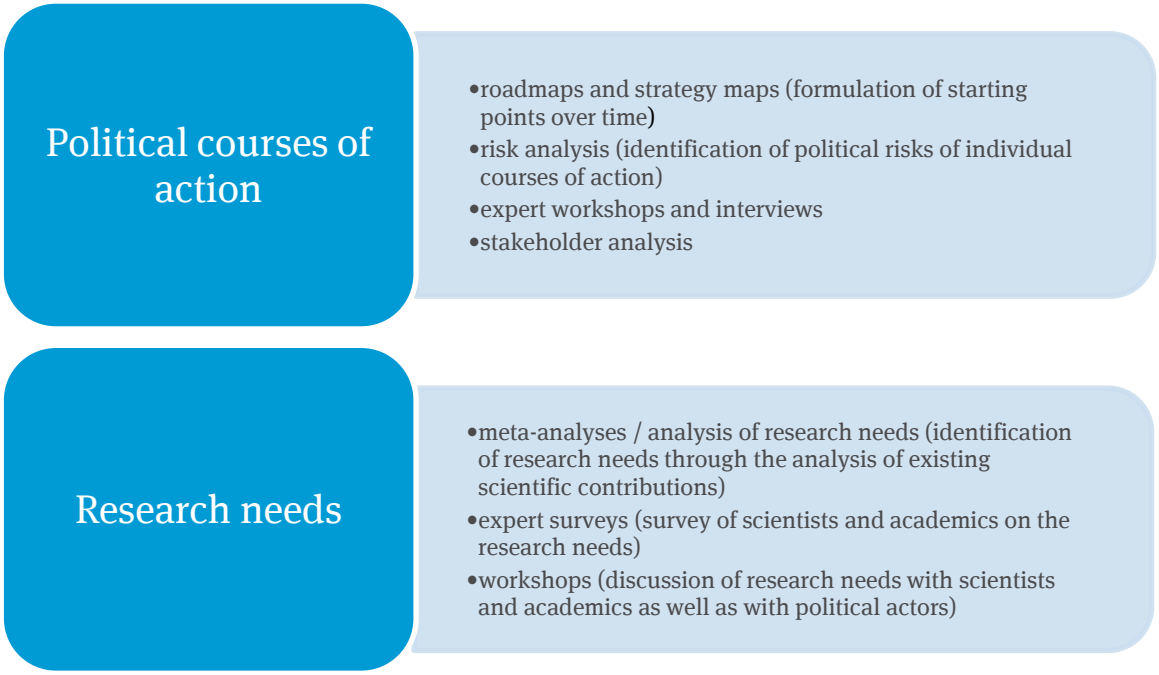
Key questions for the development of recommendations for action and research are:

- Which environmental impacts need to be addressed politically as priorities? And what environmental policy goals are derived from this (e.g. reduction of certain burdens, support of individual environmental aspects)?
- What opportunities and competencies does the Federal Ministry of the Environment have in order to address the environmental impact and achieve the formulated goals?
- What possibilities do other ministries in Germany or organisations at the EU and international level have to deal with environmental impacts?
- How should the Federal Ministry of the Environment's existing competences be expanded? Which existing policy instruments / political measures can be further enhanced, and where is it necessary to go beyond these?
- Are there any measures from other countries that could be transferred?
- Which of the previously identified actors appear to be central to the successful political management of environmental impacts and how can they be included?
- Which ministries are generally to be included in further developments? Which divisions and units at the Federal Environment Agency and the higher federal authorities should be involved?
- How can all points be translated into a strategy or an action programme?

[9] In this project, desk-based research, expert workshops and research needs analyses were combined.

- Where does further research need to be undertaken, for example to be able to identify better starting points for further research activities and policies?
- What research needs exist and where should research funding begin?

Figure 12: Methods for identifying policy options and research needs



Source: Own data and Cook et al. 2014

7 Evaluation, presentation and the transfer of results

After the individual procedures have been carried out, they are presented in a systematic and descriptive analysis report. Here again, it is particularly important to remember the objectives and target group(s) of the study in order to summarise all crucial results in a way that appeals to the target group(s) and is useful for them. It is also important to relate the individual results to each other. The following sequence chosen in this methods report is recommended:

- clarification of the preliminary explanations;
- trend description;
- results of the impact assessment;
- results of the IIC method (alternatively, also in text boxes in the impact assessment part);
- recommendations for action and research.

If the results, or at least part of them, are also addressed to the public, then a suitable and generally comprehensible language and a visually appealing form of presentation are needed. Since, on the one hand, the methodological approach has to be based on the state-of-the-art in science and also on the corresponding terminology, but, on the other, some technical terms are difficult to communicate to the public, a comprehensive editorial and linguistic revision of the results and, if necessary, graphic preparation of the text for further illustration are required.

The results of the impact assessment can be visualised as follows: green corresponds to potentially relevant positive environmental impacts, red to potentially relevant negative environmental impacts and grey to non-relevant impacts. The environmental implications of the IIC method can be illustrated by short narratives that illustrate the implications in the context of a future scenario.

The scientific documentation of the analysis (final report) should not only contain the results, but also references to the methodology used, including all assumptions and normative decisions. Especially in the case of very comprehensive studies, the chapters should be clearly structured in order to provide the reader with a common thread.

The analysis report should also contain statements on the reliability/uncertainty of the results. This last point is important because it is a study on possible future developments. In addition, an interpretation of the results should normally be part of the report. A clear distinction must be made between the results of the analysis and its policy assessment.

Environmental trend analyses will usually require the involvement of many actors and experts. Sufficient time should therefore be allowed for the review process. Whenever possible, stakeholders, interviewees and experts should be involved not only in the analysis but also in the presentation of the results.

At the end of the process, the results should be transferred for implementation. This process should be linked to the previously analysed environmental impacts and recommendations for action and research. The results could, for instance, be further disseminated in the form of reports via social networks, mailing lists, opinion columns and videos. Follow-up activities should also be initiated in order to hand over the implementation process to committed hands in order to avoid or reduce environmental risks and utilize opportunities. For example, individual units affected by the results should become acquainted with the important implications of the trend for their work and tasks in small workshops or bilateral discussions. Alternatively, contact should be sought with strategically relevant actors in order to explore possible options with them. One should not forget to plan in sufficient time, personnel and financial resources for the transfer process. Trend analyses for the Ministry of the Environment can only be successful if environmental policy, in the sense of a forward-looking environmental policy, takes up the results of the trend analysis and uses potential opportunities for the environment at an early stage and prevents potential damage to the environment and health.

8 Glossary

Direct environmental impacts	Those burdens or reliefs that arise directly from the trend in terms of time and space without social or economic intermediate steps.
Emerging issue	"Newly emerging issues that could have a major impact on environmental policy in the future." (Behrendt et al. 2015: 30)
Horizon scanning	Method of futurology; systematic identification of environmentally relevant, already emerging developments that have not yet been more strongly perceived.
IIC method	Analysis of the innovative potential of the trend, i.e. its ability to radically re-create existing conditions and the derivation of environmental impacts associated with this innovative potential.
Impact assessment	analysis of the environmental impacts of a trend
Indirect environmental impacts	Those environmental burdens or reliefs that only occur as a result of influencing or triggering social or economic changes outside the trend.
Megatrend	Long-term transformation processes of the global environment, which are characterised by a broad field of action and major effects, and affect all areas of society.
Trend	A "situation that has existed for some time, is developing, is not cyclical and is describable (empirically, statistically)" (Federal Environment Agency (UBA) 2014).
Trend analysis	in-depth analysis of a trend regarding its "nature, causes, speed of development and possible consequences" (translated from Cornish 2005: 78)
Trend description	presentation of backgrounds, driving forces and the "anatomy" of a trend
VERUM	Vereinfachte Umweltbewertung des Umweltbundesamtes (Simplified Environmental Evaluation of the Federal Ministry of the Environment)
Analysis of chain of effects	Chains of effects are a heuristic (scientific) tool to reduce complex social phenomena to particularly important (causal) effects.

9 Bibliography

Behrendt, Siegfried; Scharp, Michael; Zieschank, Roland; van Nouhuys, Jo (2015): "Horizon Scanning" und Trendmonitoring als ein Instrument in der Umweltpolitik zur strategischen Früherkennung und effizienten Politikberatung. Konzeptstudie. Im Auftrag des Umweltbundesamtes. Texts 106/2015.

Bengston, David N. (2013): Horizon scanning for environmental foresight: a review of issues and approaches: United States Department of Agriculture, Forest Service, Northern Research Station.

Bina, Olivia; Mateus, Sandra; Pereira, Lavinia; Caffa, Annalisa (2017): The future imagined. Exploring fiction as a means of reflecting on today's Grand Societal Challenges and tomorrow's options. In: Futures 86, p. 166–184.

Blättel-Mink, Birgit and Raphael Menez (2015): Kompendium der Innovationsforschung. Fachmedien, Wiesbaden: Springer VS.

Bowman, Gary; MacKay, Robert B.; Masrani, Swapnesh; McKiernan, Peter (2013): Storytelling and the scenario process. Understanding success and failure. In: Technological Forecasting and Social Change 80 (4), p. 735–748.

Burnam-Fink, Michael (2015): Creating narrative scenarios. Science fiction prototyping at Emerge. In: Futures 70, p. 48–55.

Cachia, Romina; Compañó, Ramón; Da Costa, Olivier (2007): Grasping the potential of online social networks for foresight. In: Technological Forecasting and Social Change 74 (8), p. 1179–1203.

CERF (2012): Annual Key Factors Report 2013. Cranfield University.

Cooley, Rafer; Mobasher, Bahram; Srivastava, Jatin (1997): Web mining: information and pattern discovery on the World Wide Web. In: Proceedings, Ninth IEEE International Conference on Tools with Artificial Intelligence. November 3-8, 1997, Newport Beach, California. Ninth IEEE International Conference on Tools with Artificial Intelligence. Newport Beach, CA, USA, 3-8 Nov. 1997. Los Alamitos, Calif: IEEE Computer Society Press, p. 558–567.

Cook, Carly N.; Inayatullah, Sohail; Burgman, Mark A.; Sutherland, William J.; Wintle, Brendan A. (2014): Strategic foresight. How planning for the unpredictable can improve environmental decision-making. In: Trends in ecology & evolution 29 (9), p. 531–541.

Cornish, Edward (2005): Futuring. The exploration of the future. Bethesda, Md.

Drescher, Michael; Ajith H. Perera; Chris J. Johnson; Lisa J. Buse; Ashton Drew and Mark A. Burgman (2013): Toward rigorous use of expert knowledge in ecological research. In: Ecosphere 4 (7), Art. 83.

Duinker, Peter N.; Greig, Lorne A. (2007): Scenario analysis in environmental impact assessment. Improving explorations of the future. In: Environmental Impact Assessment Review 27 (3), p. 206–219.

EEA (2001): Late lessons from early warnings. The precautionary principle 1896-2000 (Environmental issue report / European Environment Agency, 22). Luxembourg: Office for Official Publications of the European Communities.

EEA (2008): The DPSIR framework.

EEA (2015): SOER 2015: The European environment. State and Outlook. European Environment Agency.

EEA (2017): Mapping Europe's environmental future. European Environment Agency.

Fink, Alexander; Schlake, Oliver; Siebe, Andreas (2002): Erfolg durch Szenario-Management. Prinzip und Werkzeuge der strategischen Vorausschau. Second edition. Frankfurt/Main: Campus-Verlag.

Gingrich, Simone und Fridolin Krausmann (2008): Der soziale Metabolismus lokaler Produktionssysteme. Social Ecology Working Paper 107. University of Klagenfurt.

Gerhold, Lars; Holtmannspötter, Dirk; Neuhaus, Christian; Schüll, Elmar; Schulz-Montag, Beate; Steinmüller, Karlheinz; Zweck, Axel (publ.)(2015): Standards und Gütekriterien der Zukunftsforschung. Ein Handbuch für Wissenschaft und Praxis. Wiesbaden: Springer VS (Wissenschaftliche Schriftenreihe Zukunft und Forschung des Zentrums für Zukunftsstudien Salzburg, Vol. 4).

Hague, Rod; Harrop, Martin; McCormick, John (2016): Comparative government and politics. An introduction. Basingstoke, Hampshire.

Hand, David J. (2007): Principles of Data Mining. In: Drug Safety 30 (7), p. 621–622.

Heslin, Peter A. (2009): Better than brainstorming? Potential contextual boundary conditions to brainwriting for idea generation in organizations. In: Journal of Occupational and Organizational Psychology 82 (1), p. 129–145.

Holopainen, Mari; Toivonen, Marja (2012): Weak signals. Ansoff today. In: Futures 44 (3), p. 198–205.

Huber, Joseph (2011): Allgemeine Umweltsoziologie. Wiesbaden.

Iden, Jon; Methlie, Leif B.; Christensen, Gunnar E. (2017): The nature of strategic foresight research. A systematic literature review. In: Technological Forecasting and Social Change 116, p. 87–97.

Kollmuss, Anja; Agyeman, Julian (2002): Mind the Gap. Why do people act environmentally and what are the barriers to pro-environmental behavior? In: Env. Educ. Res. 8 (3), p. 239–260.

Kreibich, Rolf (2008): Zukunftsforschung für die gesellschaftliche Praxis. IZT - Institut für Zukunftsstudien und Technologiebewertung. Berlin (ArbeitsBericht, 29).

Liebl, Franz; Schwarz, Jan O. (2010): Normality of the future. Trend diagnosis for strategic foresight. In: Futures 42 (4), p. 313–327.

Mendonça, Sandro; Cardoso, Gustavo; Caraça, João (2012): The strategic strength of weak signal analysis. In: Futures 44 (3), p. 218–228.

Miles, Ian (1993): Stranger than fiction. In: Futures 25 (3), p. 315–321.

Millennium Ecosystem Assessment (2005): Ecosystems and human well-being. Washington, DC.

Milojević, Ivana; Inayatullah, Sohail (2015): Narrative foresight. In: Futures 73, p. 151–162.

Morrison, James L. (publ.)(1992): Environmental scanning. Last viewed on August 10, 2016 at http://horizon.unc.edu/courses/papers/enviroscan/default.html.

Naisbitt, John (1982): Megatrends. Ten new directions transforming our lives. 1st edition. New York, NY: Warner Books.

Oskamp, Stuart; Schultz, P. Wesley (2005): Attitudes and opinions. 3rd ed. Mahwah, N.J: L. Erlbaum Associates.

Popp, Reinhold (2012): Zukunft und Wissenschaft. Wege und Irrwege der Zukunftsforschung. Berlin, Heidelberg: Springer (Wissenschaftliche Schriftenreihe “Zukunft und Forschung” des Zentrums für Zukunftsstudien Salzburg, 2).

Popper, Rafael (2008): How are foresight methods selected? In: Foresight 10 (6), p. 62–89.

Retief, Francois; Bond, Alan; Pope, Jenny; Morrison-Saunders, Angus; King, Nicholas (2016): Global megatrends and their implications for environmental assessment practice. In: Environmental Impact Assessment Review 61, p. 52–60.

Schirrmeister, Elna; Warnke, Philine (2013): Envisioning structural transformation — lessons from a foresight project on the future of innovation. In: Technological Forecasting and Social Change 80 (3), p. 453–466.

UBA – Umweltbundesamt (2014): Vereinfachte Umweltbewertung des Umweltbundesamtes (VERUM). Last viewed on May 3, 2015 at http://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_33_2014_verum_komplett.pdf.

UNEP (2012): GEO 5. Global Environment Outlook. Environment for the future we want.

v. Groddeck, Victoria and Schwarz, Jan Oliver (2013): Perceiving Megatrends as Empty Signifiers: A Discourse Theoretical Interpretation of Trend Management. In: Futures: The Journal of Policy, Planning and Futures Studies 47 (March), p. 28-37.

Wright, George; Bradfield, Ron; Cairns, George (2013): Does the intuitive logics method – and its recent enhancements – produce "effective" scenarios? In: Technological Forecasting and Social Change 80 (4), p. 631–642.

Z-Punkt (2007): Vom Megatrend zum Produkt. Last viewed on May 3rd, 2015 at http://www.z-punkt.de/fileadmin/be_user/D_News/D_2007_06_Newsletter/Vom_Megatrend_zum_Produkt.pdf.

Zukunftsinstitut (2015): Trends – Grundlagenwissen. Last viewed on May 3rd, 2015 at https://www.zukunftsinstitut.de/artikel/trends-grundlagenwissen/.