

# Quantitative and Qualitative Information Tool about the Central Paradigms in Sustainability Research

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## ABSTRACT

This paper shows how highly sophisticated information technology tools can support sustainability research, linking different qualitative and quantitative methods. It is based on the study “From Information to Knowledge” (“Von der Information zum Wissen”), an innovative research project which deals with the allocation and use of knowledge in the realm of the emerging research field “sustainability”. It uses highly specialised advanced information technology methods to build an information system that facilitates the analysis of large research texts. The study combines the bibliometric method BibTechMon with a qualitative analysis of artifacts combined with interviews.

The study investigates the case of the research programme Austrian Landscape Research (“Kulturlandschaftsforschung”) as an example of the new scientific discipline of sustainability and develops an integrative picture of this emerging knowledge, yielding a combination of quantitative as well as qualitative results.

The basic data basis consists of 40 research reports from phase 1 of the research programme 'Sustainable development of Austrian landscapes and regions' (“Kulturlandschaftsforschung” - Austrian Landscape Research, ALR) combined with other material and interviews for the qualitative research.

The investigated text contains altogether 389 803 words. The standardised vocabulary of 20 489 words is the final basis for the analysis. The study combines the statistical analysis (BibTechMon) with a qualitative social approach (objective hermeneutics).

The research questions are: Which topics are characteristic for the sustainability scientific community? What are the inner structures of this new community, which represents a societal subsystem of the knowledge society? What are the central terms, words and combinations of words characteristic for sustainability research? Which main interdisciplinary interrelations are typical for sustainability research?

The results of the study are a dynamic data bank (“Informationssystem KLF 1”), containing all scientific reports of the first phase of the ALR programme. The data bank allows the user to locate terms and words in their original context (389 803 words, thesaurus: 20 489 words) and to detect visual clusters of Co-Word Analysis that highlight interrelations between terms and words used by the different ARL scientists.

The study combines the statistical output with the theoretical model that describes and reflects the main subjects of the ALR Scientific Community by means of the seven qualitative theses. The theses are the results of the qualitative approach using an artefact and interviews analysed with the methodology of the objective hermeneutics. This paper presents the results from combining the statistical methods with the theoretical approach of the theses of sustainability in the form of frequent bridge words and a data walk-through along the notion “protection”, as well as the word family sustainability.

## 1 INTRODUCTION

A huge amount of available information is the capital and potential of the information society, but the organisation of this information needs further steps to become a knowledge. In the scientific discourse, scientists are mostly oriented to the scientific community through their own disciplines and the produced knowledge is increasing constantly. But the challenge of the mode-2-research is to establish interdisciplinary research programmes and to communicate beyond the different disciplines, where the scientific knowledge increases year by year. The Austrian Landscape Research, ALR (“Kulturlandschaftsforschung”) is an example of an interdisciplinary research programme, addressing the new scientific discipline of sustainability. 500 Researchers, representing 40 scientific disciplines and 170 institutions were working in about 70 interdisciplinary modules on questions like biodiversity, life quality, perception, genesis and change in the landscape, multifunctionality, conflicts of usage, operationalisation, societal and physical infrastructure, water and humid areas, town and region and as well as rural development.

## 2 BIB TECH MON

Reports of large research programmes contain huge amounts of environmental information. The interdisciplinary exploitation of this information encounters numerous barriers like different interests and available time potentials which prohibit an efficient application of this generated knowledge. The method of BibTechMon is a software programme to analyse extensive text material which applies “Co-Word Analysis” and restructures the content of the material. With this software application, a different approach to existing information and a new handling of large amounts of text is possible. The software was first developed by the Austrian research center Seibersdorf, with the aim of monitoring limited information systems like databases of patents or scientific quotations. The innovative feature of the project “From Information to Knowledge” is the fact that we have extended this software to analyse large amounts of running texts in full text of scientific reports not only in abstracts.

The procedure in the project was the following: “The running text and the textual description of tables and figures were stored as a whole in an access-database. To support more detailed analyses, formal units of the reports, as for example the abstract, introduction, conclusion were encoded separately. The applied code allows the identification of all parts of the original reports, and of the modules. Finally a set of 344 text sections was analysed. The final database includes the relations to the original database of the whole texts, in order to support the identification of the primary context of a word in the reports” (Knoflacher et al 2002).

With the software of Bib Tech Mon, the electronic data material was restructured in a new system:

“Not focused on analyses of single reports, but on interdependencies among all reports. For this purpose, the relationships among the reports were calculated on the basis of the standardised word list by the Jaccard index ( $J_{ij}$ ).  $J_{ij} = \frac{c_{ij}}{(c_{ii} + c_{jj} - c_{ij}) - 1}$ . The Jaccard index measures the number of couples between two words ( $c_{ij}$ ) in relation to the occurrence of these two words ( $c_{ii}$  and  $c_{jj}$ ) in all reports. Results of these calculations are formal descriptions of the coupling intensities among all standardised words” (Knoflacher et al 2002).

We interpreted the writing of the reports as an encoding of the research texts, which normally leads to a decoding in the process of reading. Each scientific discipline applies particular code for representing its observations or ideas. In this new way, the bibliometrical method serves an interdisciplinary approach as it further continues the process of encoding and decoding which is typical for any written communication, and opens it for further interpretation in a new context.

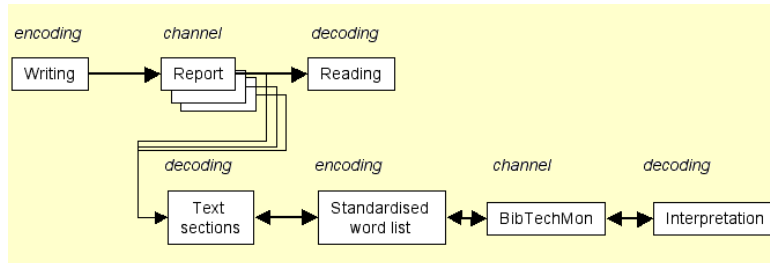


Figure 1. Impacts of the BibTechMon application on the transfer of information.

The text material of the ALR programme is now available in a visual design, established with the software program of BibTechMon in a dynamic data bank (Informationssystem KLF) This data bank allows the user to locate terms and words in their original context of the ARL reports (389 803 words, thesaurus: 20 489 words) and to detect visual clusters of Co-Word Analysis that highlight interrelations between terms and words used by the different ARL scientists.

The result of this bibliometric analysis is a network of keywords originating from all reports of the Austrian research programme on cultural landscapes which in the present analysis serves as typical example for sustainability research. It invites for qualitative as well as quantitative interpretation, even a way back through the decoding process to the original context: “All words can be presented with the whole section of the texts in the reports without any further consultation of the original reports” (Knoflacher et al 2002).

With the restructuring of keywords in a new logic, a new connection between the disciplinary information is available. As there is a common understanding of sustainability as a place for interdisciplinary communication, we now proceeded to a next interpretation loop: how can a strictly qualitative hermeneutical approach be combined with the Bib Tech Mon results?

### 3 ARTEFACT ANALYSIS

The qualitative methods of social sciences supplemented the methods of BibTechMon and introduced its potential and capacity of deep and structured analysis of process oriented paradigms. The empirical material for the qualitative approach were an artefact and a set of interviews, both were analysed using the techniques of objective hermeneutics (Oevermann 1993).

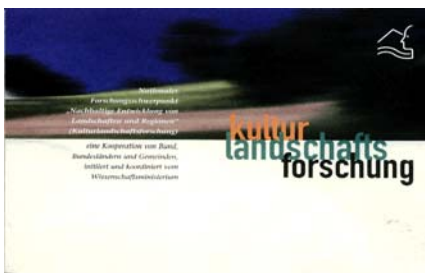


Figure 2: the artefact: folder of the ARL Research Program, first page of six

With the analysis of the artefact, the research follows the basic ideas and the paradigm of the scientific community of the ALR Scientific Community. In the objective hermeneutics loop, the meaning, expectation, and the appearance of the material, including the inputs of production, are under consideration. In addition, we conducted several interviews with scientists related to the ARL programme as programme manager, scientists or observers. After transcription of the interview material, systematic analyses, and interpretation circles with specific experts, the research continued with the process of hypothesis building in a process of verification and falsification of the emerging theses within the given material. The following theses are the results of this qualitative approach representing a theoretical model that describes and reflects the main subjects of sustainability research.

#### Thesis 1: Future

Sustainability research deals with the perspective of future ways of life and considers “to protect and to maintain” as basic values.

#### Thesis 2: Causality

Sustainability research has a larger view than the cause-effect-theorem of natural sciences and sets the context of a more complex notion of reality based on understanding.

#### Thesis 3: Idyllic Nature, Demiurgical Man

The concept of a safe and sound nature is an underlying perception in sustainability research as well as a concept of “man as a master of nature”.

#### Thesis 4: Spaces of Possibilities (“Möglichkeitsräume”)

Sustainability research is based on the idea that man/woman disposes of spaces of possibilities for his or her actions; but it tends to overestimate and overrate the possibilities of decision making by the singular individual and underestimates the societal context and the constraints of value systems, of culture and politics.

#### Thesis 5: Relocalisation (“Verortung”)

Sustainability is related to place and space and shows conflicts of usage at the example of common living places.

#### Thesis 6: Complexity

The integrative approach of sustainability research creates a compatible research methodology: interdisciplinarity, transdisciplinarity and thereby team research.

#### Thesis 7: New Research Questions

Sustainability research takes up new research fields: this research reveals latent aspects that are not yet fully thought out and are therefore a challenge for science.

## 4 THESES ABOUT SUSTAINABILITY IN A COMBINATION OF QUALITATIVE AND QUANTITATIVE DATA: BRIDGEWORDS

By the term information, this study understands structures with inherent rules for order like reports, images and texts. The same source of information can carry different levels of information (a picture or a photo, for example, carries the direct and manifest impression as well as a latent symbolical message). Knowledge, to the contrary, is the application of information in a new context – like the developing of new thoughts, the formulating of texts or the manufacturing of products. As sustainability is such a new context where information from different disciplines should be put together to form new knowledge, a combination of the existing information according to new rules constitutes a promising approach, based on information theory to guide into a harmonisation between the qualitative and quantitative methods.

Main research question: Which words and topics are typical for the emerging research field of sustainability?

The horizontal statistical analysis goes beyond the level of specialisation and the thematical definitions and shows which words are equally distributed over all report texts (within their disciplinary context, some words are used much more often than in another one). It gives a comprehensive profile of frequency (Häufigkeitsverteilung) for every keyword according to the studied reports. It came up with the following results, showing which words constitute a thesaurus of sustainability through all the reports of the Austrian Landscape Research. Statistically speaking, the bridgewords are those whose frequency above the modules in the texts have a low variance. These results represent a combination of part of the bridgewords like “system” or “environment”, which are words that are used in the different scientific disciplines and contexts that deal with sustainability. The precise definition of these words may be different from discipline to discipline, yet they form a bridge between the disciplines and can be considered as anchor words for the interdisciplinary communication. Our results allow for the thesis that sustainability has a special jargon which BibTechMon describes as words with high horizontal presence.

In this procedure, we used all sorts of words - nouns as well as verbs or adjectives, in some cases even grammatically interesting forms. They are the result of several steps of cluster analysis. Conducted by the qualitative approach, we applied a horizontal analysis (Querschnittsanalyse) and we came up with the following template.

The 86 most frequent keywords in ALR with high horizontal presence (Querschnittspräsenz):

entwicklung	169	entwickeln	66	hilfe	48	ermöglicht	30
unterschiedlich	163	theoretisch	65	einsatz	48	detailliert	30
wesentlich	141	zukunft	62	erfahrungen	48	gesamt*	29
österreich	127	ergeben	62	zeitlich	46	rasch	26
ökologisch	123	gesamt	62	viele	46	europa	25
beispiel	115	veränderung	61	praxis	44	unbedingt	24
ökonomisch	105	haupt*	58	trotz	44	änderung	24
sinn	103	wenig	57	vielfalt	44	regelmäßig	23
ziel	99	intensiv	56	erfassung	42	pflege	22
bereits	98	system	56	reihe	41	dauer	21
zeit	93	struktur	55	bewertung	40	beobachten	19
grund	84	definition	55	verwendet	40	beobachtung	18
daten	84	boden	54	pflanzen	40	eignen	18
basis	78	gruppe	54	relativ	40	erlauben	18
ressourcen	78	möglichst	53	zeitraum	39	institut	17
grundlage	78	kein	53	erhebung	36	verbessert	17
konzept	77	weg	52	wegen	35	zusammengefasst	16
schritt	77	methode	50	ansätze	34	digital	15
wasser	76	auswahl	50	bericht	34	flüsse	14
notwendig	71	anzahl	49	erkennen	32	universität	14
komplex	68	qualität	49	wiesen	32		
sollte	67	komplexität	49	zielsetzung	31		

Table 1: The 86 most frequent words in ALR with high horizontal presence (Querschnittspräsenz)

When combining the qualitative thesis process with the quantitative analysis, we can now define these notions on a combined basis. Starting from the statistical incidence, we combine the thesis of sustainability focusing on the meaning of the counted words by linguistic interpretation. Thereby the extraction as well the contextual application of the words were considered.

#### Thesis 1: Future

For the ARL programme, future orientation is a relevant factor considering it as the point of encounter between research and societal development. In the sustainability research, this aspect influences the focus of studies and research questions.

The following bridge words support the thesis that sustainability deals with the future and future strategies of development ( in descending order):

Entwicklung (development), Ziel (target), Konzept (concept), Schritt (step), entwickeln (develop), Zukunft (future), Veränderung (change), Weg (pathway), Änderung (change).

The word “Entwicklung (development)” is one of the most frequent words: This word certainly suggests that the researchers, when thinking of the future, think of change and not of a continuous extended present. They have concepts, targets and objectives, they think in concrete terms of steps to do or pathways to show.

At the same time, they show their hesitations and the fact that the sustainable change might not be so easy: many things “should” happen, “if possible”(möglichst) and are often in contradiction with the given situation – “notwithstanding” is also a term often used. In the word “future”, time is a relevant factor, representing the context of societal development: The words Zeit (time), Zeitraum (period), rasch (rapid) and Veränderung (change, diversification) show the context of time in the reports.

#### Thesis two: Causality

The ARL research focuses on societal as well as on natural processes research offers a paradigm that considers systemic interrelations. The sustainability research tends to understand the present situation in its complexity as a basis for acting in society. Therefore, words representing the causality contravene with words of a new circular thinking. Among the 86 most frequent bridge words, a set of words supports the thesis that the concept of causality is at stake in the sustainability research. In opposition to the concept of causality, sustainability moves towards a process oriented approach which is exemplified through the following horizontally frequent words: Sinn (meaning), komplex (complex), Komplexität (complexity).

Notwithstanding these hints that the ARL-researchers consider the cause-effect-theorem as obsolete, in their day-to day business they still use sets of words relating to linear processes:

Grund (cause), Grundlage (basis), notwendig (necessary), ergeben (produce), Hilfe (help), Erfahrungen (experiences), trotz (notwithstanding), wegen (because), verbessert (ameliorated).

Circular as opposed to Causal: A linguistic analysis that looked not only into the horizontal analysis, but into the overall body of words showed that both, the concept of causality as well as words representing circular approaches, find several ways of reverberation in the reports. This means that the researchers are questioning the old paradigm of cause-effect-relation, but by doing so, they get into a serious field of contradictions.

Causal: anfanglose Schleifen (loops without start), basieren (to be based), bewirken (leading to), deswegen (therefore), falls (in case), mithin (therefore), mittelbar (indirect), Sequenz (sequence), Trend (trend), Verursacherprinzip (principle auf cause), worauf (hereon), zugrundeliegend (basic), zurückzuführen auf (caused by).

Cirkular: Denkkoppelung (plugging in the thinking), dreifach disziplinärer Zusammenhang (triple disciplinary context), Entgrenzung (end of limits), zyklisch (cyclical), Wissenszusammenhänge (contexts of knowledge).

Several combinations of words show the insecurity in formulating a thought that does not yet have its precise linguistic counterform: analytischer Brückenschlag (constructing an analytical bridge), Ein-Zweckbewegungen (movements that have one scope).

In sustainability research, the concept of systemic interdependencies and of networking starts to substitute the preexisting theorem of causality. We have identified a whole field of words concerning interweaving and netting that supports this thesis:

Austauschprozesse (process of exchange), eng verknüpft (strongly linked), Verschmelzen (to merge), Schnittpunkt (intersection), benachbart (neighbouring), Bündel (bunch), enge Verflechtung (narrow interweaving), Entflechtung (de-interweave), Gefüge, gekoppelt (coupled), gemeinsam (together), Konnex (connex), Landschaftsmosaik (mosaic of landscape), Mindestkomplexität (minimal level of complexity), Puzzle, synoptisch (synoptical), Uneinheitlichkeit (non conformity), Überlappungen (overlapping), Verzahnung, Verknüpfungsregel (rule for interweaving), vielschichtig (multilayered).

As the scientific jargon does not yet offer enough wordings to reflect the new concept of systemic interdependencies, these words are often taken from a day-to-day-spoken language and transported into a scientific context. This tendency also shows that sustainability research has a more direct link to daily life issues than other traditional research fields.

### Thesis 3: Idyllic Nature, Demiurgical Man

The ARL program was developed out of the research of natural scientists observing the harmful ecological change of the natural landscape. Thus, the scientific community starts to consider the landscape as a cultural setting and as an aesthetic product of the human being. An idyllic connotation of nature shows up in some natural scientists' approaches, especially when presenting strategies to protect nature in an innocent state ("as it is"). But the human being – including the researcher – acts as "man as a creating individual". The self-conception of the sustainability researcher as a demiurg heading towards a changing world is supported by different terms – for instance "help" (Hilfe). The presence of this word shows that sustainability as world view looks for support and shows a self image of the researcher as the guiding force in the process of change. The frequency of the combination "ermöglichen" (to make possible) shows the same direction. The researchers are also aware of the urgency of their work: their results need a "basis" (Basis), and are "essential" (wesentlich). Essential is the third frequent horizontal word in the whole ARL (only development and diverse have a higher horizontal rate). When looking at phrasemes, we found images like "intakter Lebensraum" (habitat in good order) to describe what could be the aim of a sustainability approach.

Both streams, the view of nature as an idyllic entity to be protected and the wish for change and intervention, as contradictory as they may seem, are both observed in the wording of the ARL scientific community.

The fact that, in some remote corner of their being, the sustainability researcher has an idyllic, idealistic image of the world as it should be lead to what we have called "the lyric approach" that counterbalances the idea of men as creating individuals. A linguistic analysis of the writing style and vocabulary shows that here and there, this idyllic background slips even into a scientific text. Some examples of this "research lyrics":

Forschungslyrik (lyric of research): Agrarromantik (romance of agriculture), Alpenherrlichkeit (delightfulness of the alps), jungfräuliche Erde (maiden earth). These words are examples and out of the context of the reports, but they show the interpretation of nature in its lyric appearance.

Other original quotations from the text that are near to non translatability:

Bauernherrlichkeit (glorious farmership), charmantes Misstrauen (charming suspiciousness), chice Aufgeregtheit (chique excitement), heroische Erhabenheit (heroic sublimity), intakte Dörfer (villages in good order), intakte Natur (nature in good order), übersinnlich wunderbar (transcendentally wonderful), lieblicher Dorfcharakter (mellifluous village character), sich in der melancholischen Unendlichkeit verlieren (to get lost in a melancholic unboundedness), romantisches Refugium (romantic refuge), rosig leuchtende Almkuppeln (pink luminescent mountain pasture domes).

Methodological remark: These last examples can also be taken as a proof that not one single word gets lost in our data base: these phrasemes are all singular compositions made by just single researchers out of the 40; yet it is possible to detect them in our information system and even to re establish their original context.

### Thesis 4: Spaces of Possibilities ("Möglichkeitsräume")

This notion of spaces of possibilities was developed in previous theoretical work of the authors and proved to be helpful even in the context of the huge amount of texts that this study is interpreting (Dumreicher, Kolb 2003). Sustainability research is based on the idea that human beings dispose of spaces of action and that, by trying out their possibilities, they can further develop their radius of influence. In order to do this, they need examples (Beispiel), they make things possible (ermöglichen), and these actions will allow (erlauben) for new expansion of activities.

Besides the spatial context that the studies all consider as basis for their work, we can also analyse the fact that the fourth dimension – time in which the change shall occur – is a notion considered by the scholars. They have a time frame that shows the urgency and need for change in short time (rasch).

These spaces of possibilities have a target (Zielsetzung), have facilitated (ermöglicht) actions and change and are necessary without fail (unbedingt). We would certainly be curious to know what the individual researchers thought that these spaces of possibilities might allow (erlauben), and the data base "from information to knowledge" would help identifying every single original text and wording.

### Thesis 5: Relocalisation ("Verortung")

ARL shows different kinds of spaces – local, terrestrial space and space in the sense of universe. It shows the space for local action and space for local and global pollution: act locally, think globally.

ARL deals, from the very beginning, with concrete political spaces like towns, regions and other space-related, localised case studies. Although ARL is an Austrian study programme, the researchers take the larger space of possibilities into account which is Europe(Europa).

Bridge words that concern the spatial aspects of sustainability show that relocatisation, a topic counterbalancing the global aspects of change, show up with high frequency in the horizontal words. They are mostly related to ecosystems: Wasser (water), Pflanzen (plants), Wiesen (meadow), Flüsse (rivers).

Several of the space related words can be understood in a direct as well as in a metaphoric usage. This is the case for words like Boden (base), Grund (ground), Weg (path). The word base can be related to the actual question of property or soil just as well as for describing the basis for a development, or for a hypothesis. Applied in a disciplinary context like agriculture or landscaping, its meaning and context may also vary.

#### Thesis 6: Complexity

Sustainability cannot be subdivided and constantly follows a stream of complex, integrative issues. This reverberates in the methodological approaches like inter- or transdisciplinarity; it is also mirrored by the fact that most research in sustainability is done as teamwork.

The data base shows the theoretical acknowledgement of complexity with words like komplex (complex), gesamt (overall), System (system), Struktur (structure), Komplexität (complexity), Vielzahl (big number of). These words, too, follow the order of horizontal presence and show a high rate of studies that use the word.

What is not present is a vocabulary of methodology. This leads to the assumption that, although the need for complexity is recognized by the sustainability community, there is still a need for application and operationalisation.

#### Thesis 7: New Research Questions

Sustainability is often seen as a concept that is in narrow linkage with the concept of modernity and of development. This leads to a new research question: is sustainability the last outcome of the modernity theorem – or is it already an emerging post-modern era subject?

The language used in the reports shows that sustainability research opens new linguistic spaces. It is an emerging language, and there is not yet a confirmed language ductus within a terminology of sustainability. The new subject leads to uncertainty in the speech and to a series of new word creations not be found in dictionaries and to conflicts between factuality and norms. We see an emerging specific scientific jargon with its own internal code. The decoding works within the discipline even with words that are newly created – the longest word we found was „Düngemittelbeschränkungs(jahr)response“ (literary translation: yearly limitation response for fertilizer).

In order to identify the new research questions, quantitative methods obviously have a limited potential: they can serve as a counterform for missing notions. Several topics that are not mirrored in the horizontal analysis have come up in the qualitative hermeneutics interpretation loops – topics like the change of paradigm from research “against” something (namely against pollution) towards research “pro something” – for spaces of possibilities, for systemic approaches etc. Other empty spaces and black holes is the question of power relations, several levels of self reflection, and a critical apprehension of value and thinking systems in the sustainability research community.

## 5 5. OUTLOOK: FUTURE APPLICATIONS

Certainly, this analysis of the words without their context can only give an overall, rough image of the possibilities of such a data basis. In a next step, with Bib Tech Mon, we could look for partnerwords in the original texts (“What are the terms that frequently show up in relative nearness to the chosen term). in this way, one can find out what concepts for the future have been developed by the different studies. We can also re establish the original context in the whole sentence or paragraph in order to check whether our first understanding corresponds to the contextual situation.

### 5.1 A Visual Information system

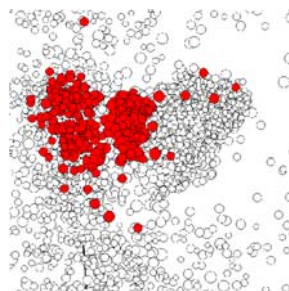


Figure 3. Example of a selected word group within the word map.

The wordmap is an interface that “delivers a two dimensional map of the relationships among all analysed words. Each word position on the map is determined by its relation intensity to all other words. In general, words of high occurrence in the reports are positioned

in the centre of the map because of the high relation intensity. In contrast, rare words have their position on the margins of the map. Word groups of common occurrence are characterised as nested within the map. Additional features of the software, like selective presentation of words within a range of occurrence, flagging of selected words, or presentation of information from the database are supporting the interactive interpretation of the maps” (Knoflacher et al 2005).

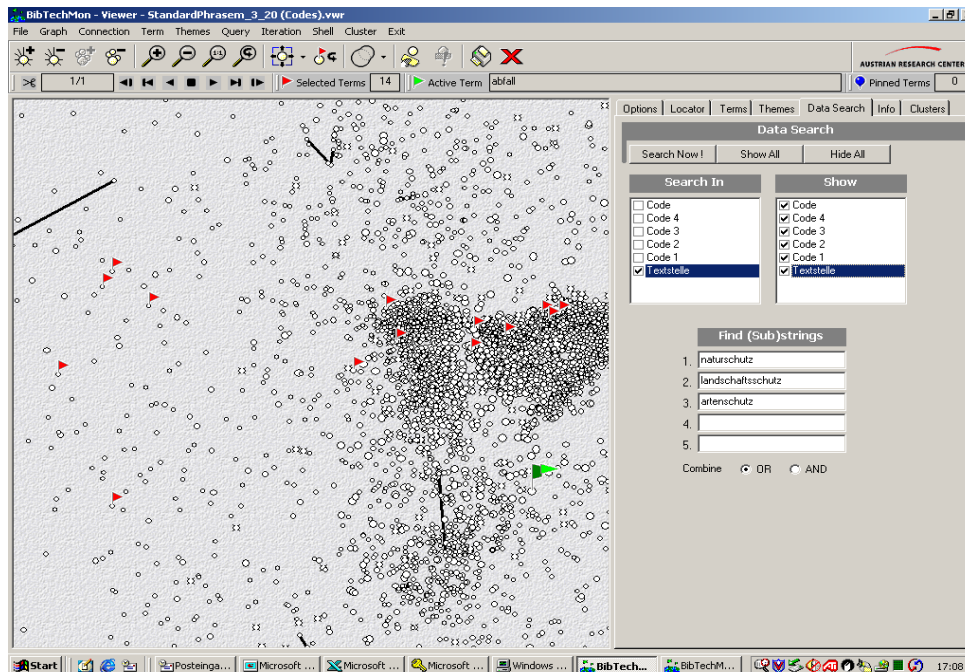


Figure 4: Wordmap presenting the selected words from the word family “Protection” which is a keyword in the traditional environmental community. Red: Nature protection. Green: protection of landscape.

The data basis itself is composed of the original text paragraphs, the phrasems and all standardised words. The context between the standardised words and the original writing in the texts is documented in the data basis. In the most simple application, the databasis can be used as catalogue of keyword. But what is more interesting is the possibility of contextual searching: starting from one specific keyword, the information system allows for discovering different sorts of connectivities, providing a basis for further research.

In the Co-Word-Analysis, the intensity of relationality between notions (words or phrasems) are analysed in relation to all other relation intensities occurring in all the reports; the graphic representations allows for quick and intuitive recognition of these relationships. Interactive maps of interdependencies among all standardised words in the reports can be developed using the BibTechMon software. With these results it is possible to identify the intensity of integration among the scientific disciplines involved in the programme, as also the relationships between scientific language and common language considered in the reports.

## 5.2 Data Walk through

The data walk-through shows how the developed data base has a possibility to manage the huge amount of information of the scientific reports even in relation to one selected word.

ample: Walkthrough along the word \*protection\*

Protection, as shown above, is a typical notion in sustainability research; the list of items that need protection can be extended endlessly.

Data walk through, step one: The data walk through starts with discovering the contextuality of words containing the particle \*protection\* (Schutz). The table shows the word protection in its combination with other notions. The fact that “protecting” has the lowest variance shows that indeed, a high percentage of all the reports contain the notion of protection as a horizontal bridgeword.

wort	Häufigkeit (code)	Varianz	BMA	IN2	IN4	IN5	KG2	KIK	LG1	MP1	MU1	MU2	MU7	OR7	SU1	SU2
schützenswert	6,0,11	0	0	0	0	0	0,2	0,3	0,17	0	0	0,17	0,17	0	0	0
schützen	8,0,12	0	0	0	0	0,13	0,4	0,1	0	0	0	0,25	0	0,1	0	0
geschützt	11,0,12	0	0	0	0	0,3	0	0	0	0	0	0,38	0,09	0,2	0,1	0
naturschutzfachlich	12,0,12	0	0	0	0,3	0,08	0	0	0,17	0	0	0,33	0,08	0	0	0
landschaftsschutz	6,0,13	0	0	0	0	0	0,3	0	0,17	0	0	0,17	0,33	0	0	0
naturschutzgebiet	6,0,13	0	0	0	0	0	0	0,2	0,33	0	0	0,17	0	0	0,3	0
schutzwürdig	5,0,13	0	0	0	0,2	0,2	0,2	0	0	0	0	0,4	0	0	0	0
bodenschutz	4,0,15	0	0	0	0	0	0	0,3	0,25	0	0	0	0	0	0,5	0
schützend	4,0,15	0	0	0	0	0	0,5	0,3	0,25	0	0	0	0	0	0	0
landschaftsschutzgebiet	7,0,16	0	0	0	0	0,1	0	0	0	0	0	0,43	0	0	0,4	0
schutzgebiet	7,0,16	0	0,1	0	0	0	0,1	0,57	0	0	0	0	0	0	0,1	0
klimaschutzpolitik	10,0,16	0	0	0	0	0	0,1	0	0,1	0,1	0	0	0	0	0,6	0,2
vertragsnaturschutz	10,0,16	0	0	0	0,1	0	0,1	0,6	0	0	0	0	0	0,2	0	0
naturschutzgesetz	8,0,18	0	0	0	0	0	0	0,5	0	0	0	0	0	0,5	0	0
artenschutz	6,0,18	0	0	0	0	0	0	0,5	0	0	0	0	0	0,5	0	0
denkmalschutz	4,0,21	0	0	0	0	0,3	0	0	0	0	0,75	0	0	0	0	0
naturschutzfachliche bedeutung	4,0,21	0	0	0	0,25	0	0	0	0	0	0,75	0	0	0	0	0
schutzgut	4,0,21	0	0	0	0	0	0,3	0	0	0	0	0	0	0,8	0	0
naturschutzfachliche bewertung	5,0,22	0	0	0,2	0	0	0	0	0	0	0	0,8	0	0	0	0
schutzfunktion	6,0,22	0	0	0	0	0	0,2	0	0,83	0	0	0	0	0	0	0
naturschutzrecht	7,0,23	0	0	0	0	0	0	0	0	0	0	0	0	0,9	0,1	0
gefahrenschutz	8,0,27	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
donauschutzübereinkommen	5,0,27	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
landschaftsschutzrecht	4,0,27	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

Figure 5: words containing the word \*protection\*.

The most frequent horizontal words shown in this table have a general character- schützenswert (worth protecting), schützen (to protect), geschützt (protected). But they are accompanied by wordcompositions that contain the protection of specific items – protection of landscape (Landschaftsschutz), of nature reserves (Naturschutzgebiet), protection of soil (Bodenschutz) or even jurisdiction of protection of landscape (Landschaftsschutzrecht). This shows how broad the field of protection is laid out in sustainability research, and we can also deduce that the topic of protection is actually carried out in the reports, pointing at specific issues that the respective research is studying in detail.

Data walk through, step two: Once we have identified the fact that protection is a horizontally present target in the ARL Research, we can now proceed to a next step.

One can now follow up the listed word and discover the original text, thereby getting a localised example for the need of protection (see also Thesis 1).

The following example shows the context of the word “protection” in one of the reports of the ARL programme:

“How do you imagine the Mühlviertel in 20 Years? I expect the Mühlviertel to look more or less like in 1999 and 2000. The farmers are working actively and are proud of their landscape. This is how it should be: one is proud of nature. The learning process is that what we called “care for Landscape” was often unfortunate for the protection of nature, for the protection of landscape and for the protection of species. Often what is given priority is “to make everything proper and clean” or “this needs mowing and three times mowing”. ... the fact that something can grow where it wants to grow is slowly getting in the consciousness of people.

Wie stellen Sie sich das Mühlviertel in 20 Jahren vor? Ich erwarte das das Mühlviertel in 20 Jahren nicht recht viel anders aussieht als 1999 und 2000 (...) Da sind Landwirte die aktiv arbeiten und stolz sind auf ihre Landschaft. Und so muß es sein daß man auf die Natur stolz ist. Der Lernprozess ist der daß das was wir "Landschaftspflege" nennen häufig für den Naturschutz für den Landschaftsschutz und für den Artenschutz nachteilig war. Sehr oft steht "das ganz sauber herrichten" im Vordergrund: "Und das gehört gemäht und dreimal gehört gemäht." Im Mühlviertel stehen die vielen Leiten und Steine der Bewirtschaftung im Weg, dass etwas dort wachsen darf wo es wachsen will dringt erst allmählich ins Bewusstsein. Und das es toll ist die Kulturlandschaft die sie haben wenn sie in den Talbö-den die Wiesen noch haben und wenn das sogar feuchte Wiesen sind die einen gesunden Wasserhaushalt anzeigen (Favry, Hiess 1999)“.

## 6 CONCLUSION

In the emerging scientific landscape of sustainability, a theoretical approach accompanying the published research can give a picture about the interdisciplinary qualities of the reports and about the topics dealt with. The following table shows the wordfamily sustainability and the manyfold connotations that the reserachers have mentioned.

nachhaltige entwicklung	67	nachhaltiges ressourcenmanagement	3	nachhaltige entwicklung	67	nachhaltiges ressourcenmanagement	3
nachhaltigkeit	63	nachhaltigkeitsforschung	3	nachhaltigkeit	63	nachhaltigkeitsforschung	3
nachhaltig	56	nachhaltigkeitsprinzip	3	nachhaltig	56	nachhaltigkeitsprinzip	3
nachhaltiger umgang	9	nachhaltigkeitsprobleme	3	nachhaltiger umgang	9	nachhaltigkeitsprobleme	3
nachhaltige kulturlandschaftsentwicklung	8	nachhaltigkeitsstrategien	3	nachhaltige kulturlandschaftsentwicklung	8	nachhaltigkeitsstrategien	3
nachhaltigkeitsindikatoren	8	nachhaltigkeits szenarien	3	nachhaltigkeitsindikatoren	8	nachhaltigkeits szenarien	3
nachhaltigkeitskriterien	7	nicht nachhaltig	3	nachhaltigkeitskriterien	7	nicht nachhaltig	3
nachhaltige landschaftsentwicklung	6	lokale nachhaltigkeit	2	nachhaltige landschaftsentwicklung	6	lokale nachhaltigkeit	2
nachhaltige mobilitätsentwicklung	6	nachhaltige kulturlandschaft	2	nachhaltige mobilitätsentwicklung	6	nachhaltige kulturlandschaft	2
nachhaltigen kulturlandschaftsentwicklung	6	nachhaltige raumentwicklung fe	2	nachhaltigen kulturlandschaftsentwicklung	6	nachhaltige raumentwicklung fe	2
nachhaltiger	6	nachhaltige verkehrsentwicklung fest	2	nachhaltiger	6	nachhaltige verkehrsentwicklung fest	2
nachhaltige nutzung	5	nachhaltigen ressourcenmanagements	2	nachhaltige nutzung	5	nachhaltigen ressourcenmanagements	2
leitbild nachhaltige entwicklung	4	nachhaltigen systemen	2	leitbild nachhaltige entwicklung	4	nachhaltigen systemen	2
nachhaltige mobilitätsabwicklung	4	nachhaltigen verkehrssysteme	2	nachhaltige mobilitätsabwicklung	4	nachhaltigen verkehrssysteme	2
nachhaltige regionalentwicklung	4	nachhaltiger entwicklung zweckmäßig	2	nachhaltige regionalentwicklung	4	nachhaltiger entwicklung zweckmäßig	2
nachhaltiges bauen	4	nachhaltiges wirtschaften	2	nachhaltiges bauen	4	nachhaltiges wirtschaften	2
ökologische nachhaltigkeit	4	nachhaltigkeitsdebatte	2	ökologische nachhaltigkeit	4	nachhaltigkeitsdebatte	2
soziale nachhaltigkeit	4	nachhaltigkeitsdiskussion	2	soziale nachhaltigkeit	4	nachhaltigkeitsdiskussion	2
nachhaltig konzipiert	3	nachhaltigkeitskonzept	2	nachhaltig konzipiert	3	nachhaltigkeitskonzept	2
nachhaltige landwirtschaft	3	nachhaltigkeitsorientiert	2	nachhaltige landwirtschaft	3	nachhaltigkeitsorientiert	2
nachhaltigen mobilitätsabwicklung	3			nachhaltigen mobilitätsabwicklung	3		

Table 1: Wordfamily sustainability



Conclusions concerning a new methodology of scientific management:

Besides new knowledge about the nature of the upcoming new research field sustainability as shown in this paper, the project "From Information to Knowledge" also shows how such a combination of qualitative and quantitative methods can sort out central targets out of a huge compound of texts. This can be a tool to make these results available for interdisciplinary communication. It can also be a tool for managing large research programmes.

Conclusions concerning the combination of qualitative and quantitative methods:

From the methodological point of view, the cooperation between natural and social sciences was beneficial. In the first phase which established the list of standardised words and up to the last steps namely the interpretation loops, the software specialised recognized how beneficiary the combination of qualitative and quantitative methods in the research team proved to be:

"In comparison with former analyses of large reports with BibTechMon, an essential improvement of the results could be found out by the integration of qualitative and quantitative methods. These effects are caused in particular by much more sophisticated approaches in identification of text sections, and in standardisation of words by the integration of hermeneutic and linguistic methods. Caused by the huge dimension of the standard words database, no singular result of these analyses can be expected. Interpretations by the project team are therefore exemplary, and not complete. Consequently, the main result of the project was achieved by integration of the word databases in the BibTechMon software." (Knoflacher et al 2002.)

Conclusions concerning sustainability research:

The young research field sustainability is developing its own specific scientific language and can also be characterised by a set of topics that differ this research field from the previous field "environmental sciences". The qualitative as well as the quantitative research show the following notions as a set of topics that constitute sustainability research: Thesis 1: Future, Causality, Idyllic Nature and Demiurgical Man, Spaces of Possibilities ("Möglichkeitenräume"), Relocalisation ("Verortung"), Complexity, New Research Questions.

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- Note 2: The research programme 'Sustainable development of Austrian landscapes and regions' (short Austrian Landscape Research, ALR "Kulturlandschaftsforschung") is a cooperative initiative of the Austrian federal government, the state governments and several municipalities, initiated and coordinated by the Federal Ministry of Science.
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