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MASTERARBEIT

Titel der Masterarbeit

Gaining a Picture of Science?

Visualisations in the Research Community of Scientometrics and Informetrics

A Case Study at the ISSI Conference 2013

verfasst von

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Content

1. Introduction

The way images are produced, presented and interpreted in scientific publications and presentations is a relatively new research topic, yet it is of growing importance since producing and sharing images has never been as easy as it is today. With digitalisation and therefore simplification of image production, the general use of visualisations has been increasing significantly not only within the scientific context, but it has also changed the way science and its outcomes are perceived. According to Silverman, the interest in analysing visualisations is linked to the general rise of humanities and culture related disciplines: "*with the burgeoning of cultural studies within social science, the study of visual images has become a highly fashionable topic*" (Silverman 2006, 264). Mitchell refers to this as the *pictorial turn*, the change of both popular and academic culture(s) and he develops the studies of *visual culture* (e.g.: Mitchell 1995; Mitchell 1996).

The rising prevalence of visualisations is definitely observable in the field of scientometrics. By screening publication abstracts of one of the field's most important journals - *Scientometrics* (by Springer Netherlands) – one can track the frequency of usage of the term "visualization" or "visualisation" which has been significantly increasing in recent years. Based on a simple search in Elsevier's Scopus database, the number of mentions is 270 for all publications in *Scientometrics* between 2003 and 2013. Before this time span tracking back to 1996, the term can only be found 34 times[1]. In parallel and since the nineteen seventies there has been a rising interest in science studies examining how these cultural changes of using images also change the way scientific output is produced, engaged and deployed (Lynch 2006; Burri and Dumit 2008) with(in) pictures and what ways their audience perceives, translates, deconstructs and interprets these new forms of *visual knowledge* (Galison 1997; Beaulieu 2002).

With my professional interest in scientometrics and my background in the Social Studies of Science and Technology (STS), these two developments drew my attention. Coincidentally, it turned out that in the year dedicated for my master thesis the world's biggest scientometrics conference, the ISSI 2013, would be held in Vienna, so a great occasion for studying visualisation habits of this specific research community opened up. I took this opportunity for framing an ethnographic case study by having a closer look at the *performativity* (Law 2009) of the images used in the context of this scholarly meeting. This endeavour was considered

[1] Source: Scopus (http://www.scopus.com/); Query: SRCTITLE(scientometrics)

as relevant since this community works frequently at the interface of science and science policy making and thus the question of knowledge politics and what role images can play suggests itself.

The International Society of Scientometrics and Informetrics (ISSI) Conference[2] is the core conference for the disciplines of scientometrics and informetrics and serves to "*provide an international open forum for scientists, research managers, authorities and information professionals to debate the current status and advancements of informetric and scientometric theories and their deployment. In addition to the traditional evaluative focus, this conference will also discuss practical applications in related fields such as library and information science, history of science, philosophy of science, etc."* (International Society of Scientometrics and Informetrics 2013)

Dealing with meta-data on scientific performance and the natural abstractness of this data or the calculated indicator values open up a broad range of visualisation practices to enable a faster, more intuitive understanding of what the observed publication patterns and indicators on science and technology outputs mean. But what is this intuitiveness all about? How can these graphs, nets and diagrams be read and what are they representing? Whom are these pictures made for and with what (political) implications? On what arenas and platforms do these pictures play a role and how do they perform?

My personal interest in these issues has some history. I started dealing with bibliometrics through my position as a researcher at the Centre for Social Innovation in Vienna (ZSI)[3] with an academic background in media as well as science and technology studies and some working experience as a librarian. The team for co-publication studies at ZSI of which I am still part of, deals with the analysis of collaboration patterns in international context(s) and uses mainly quantitative data, therefore feeding into the scientometrics discourse by for example active participation in the ISSI Conference 2013. We are not only processing, standardising, cleaning, analysing and interpreting the data ourselves, but also applying different methods and techniques to visualise them. This made me an observer of our own work at the ISSI conference, because together with my colleagues we presented some of our results in one of the panels and I in turn participated as a researcher in the context of the present study. Additionally our team conducted a workshop on visualisation at the pre-conference day. Consequently certain partiality in the matter must be accepted since I am changing positions and analyse the visualisations presented from a qualitative and science studies' (STS) perspective. Yet it can also be regarded advantageous that I have certain

[2] http://www.issi2013.org/
[3] http://www.zsi.at/

technical understanding of and basic knowledge about the processes involved in creating these images for their reflection and analysis.

Scientific Image processing is an ambivalent instrument. On the one hand, it conveys insights into worlds that have remained occult to humanity for centuries. On the other hand, it only makes visible what passes the arbitrarily chosen filter of our measuring instruments. During this process it is easily forgotten that science only provides models of the world but is never able to picture reality itself.

The present study is a snapshot of visualisation habits within a specific scientific sphere, a certain group of researchers locating themselves as part of a yet very young scientific community, performing in the context of a three days conference setting. While there have been studies on how certain types of visualisations are made (cf. e.g. Latour 1995; Prasad 2005; Pauwels 2006a; Mayer 2011a) and instrumentalised (cf. e.g. Dumit 1999; Joyce 2005), focus has not often been laid on how these images *perform* in a certain context (Law 2009), in what ways scientific visualisations are *engaged* and *deployed* (Burri and Dumit 2008), how they are subject to discussion and reflection or what roles they are ascribed to by the various stakeholders confronted with these pictures. Exactly this scope of observation is tried to be tackled by this study.

Choices of methods were determined to some extent. Not only, because the social studies of science have a tradition of observing scientists in their professional environment (Beaulieu, Scharnhorst, and Wouters 2007), but also because my personal approach to conducting a thesis was guided by the elementary decision of including an empirical part which consists of talking to individuals in the field. Therefore an ethnographic case study was designed.

Structure-wise this thesis does not hold innovative surprises, as it starts with an overview of relevant literature on the topic, but also arranging the theoretical framework of analysis, followed by a short chapter dedicated to elaborate the research question, discussing it in its different aspects. The subsequent section specifies research conduct, arguing choices of methods, the way they were applied and how data was analysed. The end of this section consists of a critical reflection of the possibilities and limitations of this study before the ensuing section starts describing the case as well as the field and the way it was accessed. Chapter 6 brings together theory and empirical observations and formulates results that are then more closely interpreted and contextualised as well as put into perspective in the final section.

2. Visualisations in Scientometrics

In this chapter a picture of the state of the disciplines and discourses relevant to this study is created, forming the basis for deducting theoretical concepts and methodological framework for research conduct to be operationalised in chapter 4 *Research conduct* and the case study during field research (chapter 5 *In the Field: ISSI 2013*).

The first section 2.1.*Scientometrics* provides a brief introduction to bibliometrics, scientometrics and informetrics and a brief historic overview of how these disciplines emerged and what the most important discussions strands can be observed at the moment. Furthermore the notion of the *scientific community* is discussed and developed as an object or frame set of analysis for this study.

Section 2.2 *Illustrating Dynamics in Science* illuminates in a schematic way how images are made in scientometrics with some reflections on the specificities of representations of bibliometric meta-data – which itself is presented with the help of visualisations.

The third strand in section 2.3 *Representations of Scientific Knowledge* focusses on scientific images as specific form of scientific knowledge, but also as a manifestation of social values, as co-production within various disciplines and research groups, as a piece of art or as a means of politics and as an actant itself, in order to eventually understand how images are instrumentalised to for example make research results in these discussions easier to understand or interpret (e.g.: Leydesdorff 2001). Understanding scientific imaging is divided into three generic sub-chapters according to the phases of production, engagement and deployment (Burri and Dumit 2008). A last sub-chapter is devoted to the notion of *performativity* as visualisations' role in enacting *collateral realities* (Law 2009).

2.1. Scientometrics

"Scientometrics is concerned with the quantitative features and characteristics of science and scientific research. Emphasis is placed on investigations in which the development and mechanism of science are studied by statistical mathematical methods." (Springer 2013)[4]

2.1.1. Entering the Discipline

The field of scientometrics emerged in the nineteen sixties in context of the creation of the Science Citation Index by Eugene Garfield (Garfield 1964; Garfield 1979). Endeavours to

[4] From a self-description of the journal *Scientometrics*, published by Springer Netherlands and co-published by the Akadémiai Kiadó, Budapest, Hungary with the current Editor-in-Chief: Tibor Braun

formally measure and evaluate scientific output have been made before (as for example described by Godin on the attempts of listing “men in science” in the mid eighteen hundreds (Godin 2007)), however, it has only appeared in the second half of the 20th century as an own scientific discipline (Leydesdorff 2001).

The definition for Scientometrics as it is chosen in the *International Encyclopedia of Social and Behavioural Sciences* is the “*study of the quantitative aspects of scientific communication, R&D practices, and science and technology policies”* (Leydesdorff 2001, 13752). It is a field that deals with quantitatively measuring science outputs and endeavours to standardise data that is compiled in order to develop and apply indicators for various purposes, for instance science policies and research management.

While the sociology of science, in the sense of sociology of scientific knowledge, mainly develops and applies qualitative methods to analyse practices in science on a micro-level (individual), including informal communication, scientometrics is considered as being closer to library and information sciences as it focusses on formalised, quantifiable communication or texts/documents like scientific publications as empirical units of analysis and it deals with scientists as authors (Leydesdorff and Milojević 2001).

From its beginnings in the Science Citation Index – SCI (Garfield) a countless number of rankings, indicators and databases have emerged, constantly being controlled, cleaned and improved by enterprises that have made a business model out of it.

With the spreading of the internet, digitalisation and the improved and increased ways of tracking, indexing and storing meta-data, the size of information storages and data-sets have increased exorbitantly and therefore so have the complexity and labour intensity of dealing with this data. Analysing huge amounts of information has become a multidisciplinary issue. Visualising, even more so a multidisciplinary endeavour, has become a mode of understanding these complex sets of data e.g. in the case of modelling network dynamics with the help of visualisations.

Major threads in current scientometric discourses are: impact measurement, citation theory, the definition of reference sets and classification systems, science mapping and the contexts indicators developed for policy and management (Leydesdorff and Milojević 2001).

Creating and developing figures and systems of indicators on the performance of the scientific apparatus and its outputs, which are not only discussed academically, but utilised in the context of science policy, strategic decisions at scientific institutions, is often translated into popular rankings.

Already in 1990 it was stated that "[c]*itation analysis has conquered the world of science policy analysis*" (Leydesdorff and Amsterdamska 1990, 305) yet not without criticism. With this the scientometrics community enters the field of politics of knowledge, leading to a range of questions on ethics and responsibility.

What Brenneis, Shore and Wright allude as "*coercive commensurability"* (Brenneis, Shore, and Wright 2005), Espeland and Sauder refer to as the "*proliferation of quantitative measures of performance"*, which they claim "*is a significant social trend that is fundamental to accountability and governance; it can initiate sweeping changes in status systems, work relations, and the reproduction of inequality.*", (Espeland and Sauder 2007, 2) and related to problems of reactivity in the sense of effects of self-fulfilling prophecy and commensuration. The authors argue that while creating quantitative measures for accountability, the measured objects themselves change their behaviour permanently through reflexive adaptation to the scheme (reactivity) (Espeland and Sauder 2007).

"*Reactivity is one form of interaction that reveals how difficult it is to maintain sharp distinctions between measures and objects of measurement, description and inscription, science and society, the social and the natural.*" (Espeland and Sauder 2007, 35)

The authors observe that through the tendencies of quantifying accountability with the help of publicly available measures, these numbers are being taken for granted and replace more qualities or attributes that are more difficult to be explained and therefore are not as easily decontextualised, depersonalised, comparable and highly portable like measures that were made quantifiable and expressed in numbers (Espeland and Sauder 2007, 18). As a consequence, this easier accessible and processable information in form of figures appears less uncertain and contingent while supposedly gaining robustness and definitiveness (Espeland and Sauder 2007, 17).

This robustness is highly contradictive when considering the fact that there is an *"inherently multidimensional character of citation"* (Leydesdorff and Amsterdamska 1990, 306). It has also been found that inconsiderable of the discipline they are working in, researchers do not nearly cite everything their work is based on (e.g.: MacRoberts and MacRoberts 2010, 1).

The trends of quantification and accountability are observed in different kind of spheres, strongly in policy making; accordingly scientometrics developed to receive decent attention in science policy. One may even argue that scientometrics itself has turned to be a support of a transition in knowledge production towards what Gibbons et al. coined as the *Mode 2* (Gibbons et al. 1994; Gibbons 1994) by delivering means and measures for the demand of science to become more accountable.

As Martin (2011) analysed recent developments in the bibliometrics community according to the elements of a new form of knowledge production which was called *Mode 2* by Gibbons and others (Gibbons et al. 1994). This new mode describes a change of how research is carried out in the sense that research outcomes are more contextualised to their application in society, which asks for different forms of social accountability and quality assessments. Knowledge is produced in transdisciplinary environments and includes a more heterogeneous set of institutions. All these four elements were found at least partly true for bibliometrics. As has been examined by Martin, the field of bibliometrics itself is object to this transition and subject to support this process (Martin 2011).

Martin observes that highly cited articles in scientometrics are becoming more concerned on how they are serving policy making (contextualisation) and an increase of interest in research evaluation suggests an increase in external accountability. As for the institutional heterogeneity, scientometrics has been assessed as quite diverse from the beginning. Although or maybe because the scientometrics research community is very young, the variety of backgrounds and other disciplines *scientometricians* come from is remarkable. As has been observed in the field of this study, it is not only statisticians or mathematicians dealing with numbers and indicators, but also researchers, practitioners or analysts in economics, business and management, as well as scientists from all disciplines with an interest in understanding their own communities' dynamics quantitatively and increasingly technicians, database and visualisation specialists, programmers and software engineers, etc. Martin describes this diversity as multidisciplinary in the beginning, which later developed towards interdisciplinarity and has traces of transdisciplinarity (Martin 2011, 468). As compared to multidisciplinarity, inter- and trans-disciplinary research not only adopts inputs from other fields, but integrates them (inter-disciplinarty) and even incorporates and further develops them (trans-disciplinarty) as described by Klein (Klein 2010).

In a last step of approaching the discipline, the broader topical environment is opened up and the present is study located within it. Taking Leydesdorff's three dimensions of the dynamics of sciences, namely primary actors of science – people and institutions – as one axis, scientific content or theories as second and the "haptic" outputs such as texts or journals as a third, the related disciplines move along only two of the three dimensions each. Taking different perspectives on the dynamics of science: sociology of science as dealing with individuals and groups and their scientific knowledge and interaction, philosophy of science is more interested in textual analysis of scientific outputs (which is also the case for artificial intelligence, but yet from another, more technological approach) while, in the third place there is scientometrics, dealing with people/institutions and their quantifiable textual outputs.

In this thesis all of these spaces are considered from different angles (purple comments in Figure 1):

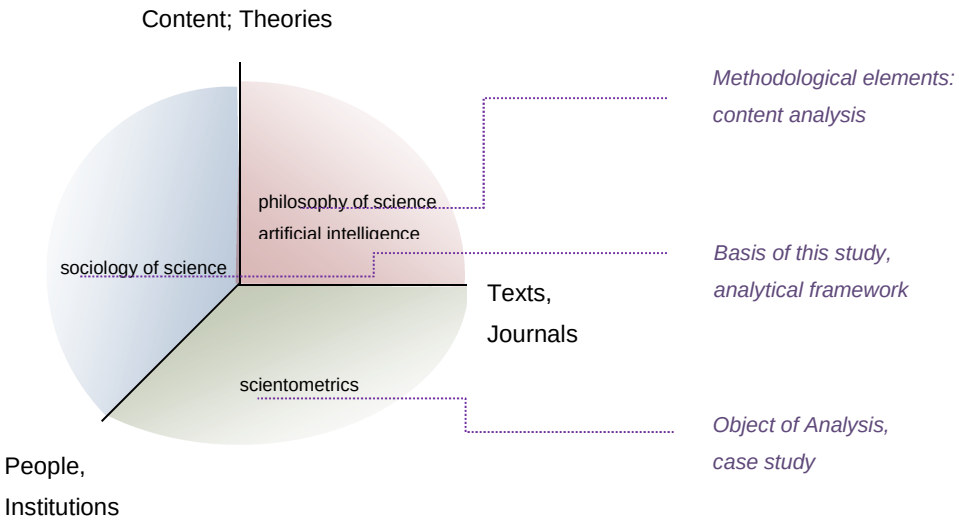


Figure 1: Three main dimensions in the dynamics of the sciences and the positioning of this thesis (purple comments); adapted from Leydesdorff and Milojević (2001)

The present study takes its main position and argues from a perspective that derives from the sociology of science dealing with scientists and researchers in a certain discipline (*people, institutions*) and observing how they present their contents and theories (*content, theories*) by mainly analysing qualitative data (blue zone in Figure 1). As a study object it focusses on the discipline of scientometrics (green zone), which combines the dimensions of *people and institutions* and their output (*texts*) and assesses these in a rather quantitative way. Analysing *texts* for their *content* also materialises in this study: as one element within the methodological framework of content analysis constitutes a preparatory method to understand and open up the field for the case study.

At this point it has been roughly grasped, what scientometrics is about in terms of its research contents and contexts. Now closer attention will be directed to the actors of the field that comprise and shape the scientometrics community.

2.1.2. Entering the Community

An essential issue for the sociology of scientific knowledge as well as for the present fieldwork observing members of a specific scientific discipline is therefore the definition of the notion of the *scientific community*.

What Fleck (Fleck 1979) names *thought collective* and *thought style* and similarly Kuhn (Kuhn 1962) refers to as *community* and *paradigm* are the first considerations of how to describe the social entities where knowledge is “produced” and how and under what circumstances this is happening. They both, however, do not clearly state the criteria and

boundaries with which these communities or social entities can be identified (eg. Jacobs 1987).

With science developing to be more multi- or trans-disciplinary, the term *community* was rather substituted by the notion of *network* including researchers from different specialties and disciplines. Knorr-Cetina has coined the concept of *transepistemic arenas* which not only includes researchers from other academic domains, but any social setting research is made and therefore also informal communication, creating *resource relationships* bound to not only scientific, but also pragmatic considerations and agreements. For Knorr-Cetina the scientific community taken as a *taxonomic collective* (shared concepts; logical class) is something different than the concept used by the participants of a community themselves (Knorr-Cetina 1982).

To operationalise the concept of *community* for the present study, the author asked herself, whether and how she would define herself as a scientometrician or bibliometrician and whether and how she was perceived as such in the conference setting. Apart from having had an active role at the ISSI conference in several ways (as co-author of a paper, co-organiser of a tutorial as well as a "metascientist" in the conference), which would formally put her into the role of a researcher inside the community, being perceived and noticed as an actor in a community or as an entity in the respective network, also requires the usage of certain epistemic frameworks, theoretical concepts, methodological tools and vocabulary in the *interaction* with other individuals active in the community, be it orally through a presentation or again formally, through publishing, citing and being cited. Ironically exactly the last mentioned processes of participation in a community are the traces of dynamics within *science* that are the research object and being measured by the scientometricians themselves. This fact leads to the peculiar conclusion that in the specific case of scientometrics, the community partly defines itself through the object of its own research.

Yet it cannot be expected that scientometricians can steer the social dynamics that shape their community, so going back to the question of whether the author is considered as part of the scientometric community, the only possible answer would be "*probably*". Consequently, the conceptualisation of *scientometrics community* could not be a static one. Rather, it was accepted, that in order to operationalise the concept, a pragmatic solution was needed, leading to the deliberation of defining it as a temporarily and spatially limited entity according to the framing of the research question.

Therefore the underlying premise for the sake of this study is to assume that all participants at the ISSI'13 are in one way or the other active in the field of scientometrics in the broadest sense. The limitations of being an *actant* and therefore being part of this scientific community

is yet blurry, as it is related to the definition of the notion “contribution”. According to this pragmatic concept of defining all participants of ISSI as part of the community, individuals can not only take part in the scientific discourse by publishing in established scientific journals, but also for instance by joining the discussion at a topical conference like the one in focus here. For a certain moment in time and by being actively present at this specific space, each individual – even the author herself – shapes the perception, dynamics and self-understanding of a scientific community and therefore becomes a gladiator in the *transepistemic arena* (Knorr-Cetina 1982) or part of the peer community, yet not necessarily permanently. In the context of the present study, all participants at the ISSI’13 are assumed as related to the community of bibliometricians and as the performativity aspects in panel presentations is analysed, all individuals active in discussions are accepted as actors inside this community.

Groups of individuals apply various strategies for stabilising what they consider as their community. Central authors (measured by scientific output) are honoured with prizes (in the case of bibliometrics: the *de Solla Prize Award*) and are assigned to holding key note speeches or for writing pre-faces in their domain’s publications. Networks around these individuals could then be considered as the core of the community as it is perceived – and being measured with the help of network studies and centrality measures resulting in social network diagrams as also discussed later in this study.

2.2. Illustrating Dynamics in Science

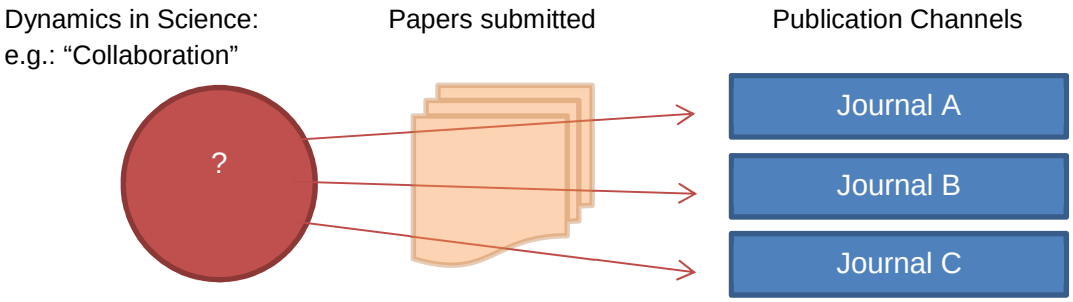
Although the types of visualisations, graphs and diagrams used in the framed field by scientometricians are manifold, the most iconic images in the field are probably derived from network diagrams and science maps – both of which have some concept of *scientific collaboration* as starting point of analysis. In the following section we have a closer look at how collaboration in science is depicted based on mainly quantitative data in a scientometricians’ realm.

As opposed to *directly observable physical referents*, visualisations in scientometrics are not so much *depictions of real world phenomena*, but have *mental* referents, meaning that they are visual data representations or are *purely mental constructs that has no ‘pre-existence’ in the physical, historical world whatsoever* (Pauwels 2006b, 3). Yet this kind of visualisations with mental referents are ascribed an important function to explain or impact the *real world*.

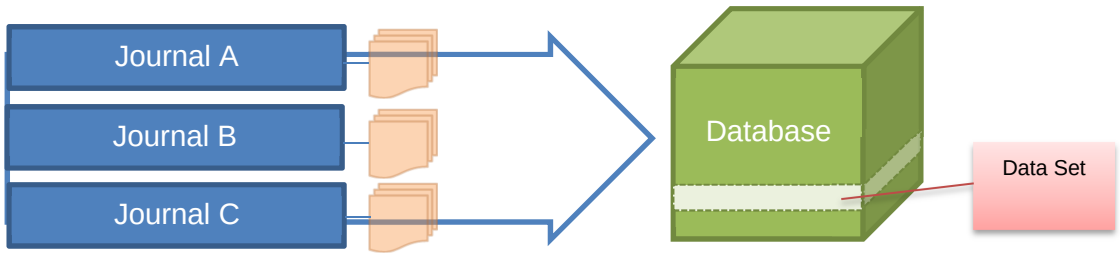
Any kind of representation inheres “*implicit or explicit theory”,* they “*embody specific norms and values”* and “*every representational process involves a translation or conversion of some kind”* (Pauwels 2006b, 3, 5 and 4 respectively). Also basing on Bastide’s observation of an

increasing prevalence of "*illustrations that are photographs of "traces" produced by automatic techniques that displays results in a two-dimensional form*" (Bastide 1990, 203). Below it was to sketch a simplified three-step overview of the abstraction, translation and representation processes that eventually make it possible to visualise the "traces" of some sort of measured scientific collaboration:

Representation and Translation Step I: Abstraction of (co-)produced knowledge to formalised output



Representation and Translation Step II: Translation of scientific (collaborative) output to data base entries by collecting meta-data; selection of data sets



Representation and Translation Step III: Manipulated data sets are turned into visualisations[5]

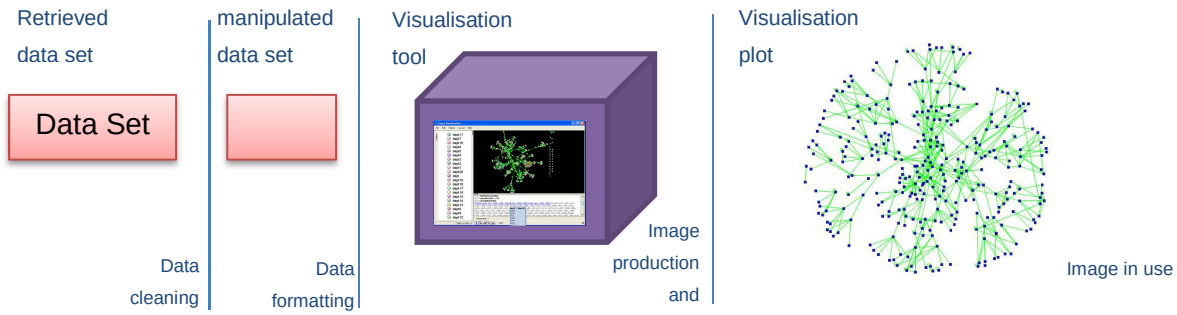


Figure 2: Sketch of a schematic three-step abstraction and representation process of visualisations in scientometrics; source: own graphic

[5] The social network visualisations in this figure are taken as examples from an arbitrary open source tool called GUESS, available at http://graphexploration.cond.org/look.html#screenshots.html

In step I we have the *science* with some certain processes and dynamics *inside* – some of which might be of collaborative nature – and certain publication activity that for instance results in articles that are (or are not) published in scientific journals. Co-publication, which is the case when an article has two or more authors, is commonly used as an approximation of collaboration, although it is obvious that not all scientific collaboration *turns* into a published document – not even closely to *all scientific knowledge* does. And not all papers submitted are published as journal articles. Notions of scientific knowledge and collaboration are translated to publishable documents which are represented by scientific journals or other publishing channels, testifying and approving it as *scientific knowledge* or *collaborative* – in the sense of how it is measured afterwards.

In step II we find the meta-data of published articles collected by for instance library catalogues or citation databases, forming another representation process of listing data about what is being published to become database entries. Articles are translated into items in a list and in this sense become *traces* of what is being published. It is impossible to keep track of *all* articles published, since not all journals are indexed by the common citation databases. English speaking journals are preferred to journals in local languages, “high ranking” journals are focussed and generally conference proceedings papers and journal articles are the most common “document types” tracked, while other media only shape a small share of the total elements covered. Inevitable certain power is ascribed to these databases as they help to structure and weigh scientific output. Data can be retrieved by database queries which define the set of interest (e.g.: co-publications) and extract the information for analysis. Not all relevant elements might be found in this step, due to errors on the side of data indexing, algorithms, query language or just human mistakes.

In step III we find the retrieved data being cleaned and translated to meet the parameters and standards of the visualisation tool of choice. The data set’s complexity is reduced and selected parts of the data are being represented to shape an image illustrating “what is inside the data set”. Theoretically, following Latour’s concept of both processes happening in parallel, *reduction* and *amplification*, we find the data now being in its most amplified status in terms of comparability, standardisation and relative universality, but also in its most reduced status in terms of variety, uncertainty and diversity (Latour 1995, 181).

Both processes ideally and at least theoretically should be reversible, meaning that the final network visualisation should potentially be de-constructed to become science dynamics and vice versa. Examining now the whole process from activities in science to their traces in visualisations, we can apply two perspectives, asking on the one hand, how “science” is being translated to look like a network and on the other hand, how network visualisations or

science maps shape the ideas we have about “science”. Bringing this thought back to the illustration above, the starting point and the final product juxtaposed would look the following Figure 3:

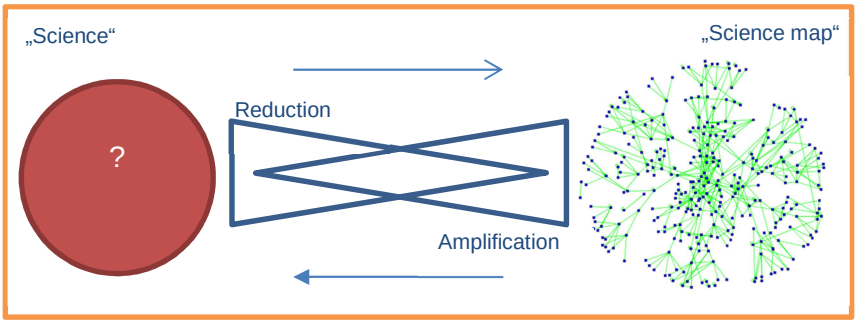


Figure 3: Reduction and Amplification based on a sketch by Latour (1995) and transferred to the example of depicting collaboration in science as a science map; source: own graphic based on Latour (1995, 181)

What started as a description of visualisation steps in scientometrics is now being turned into a deepened theoretical discussion of what implications there are in creating and utilising scientific visualisation and how they perform within different application purposes.

2.3. Representations of Scientific Knowledge

In several different disciplines like philosophy, history, art science, anthropology, psychology, semiotics and linguistics, as well asin technological disciplines (e.g.: imaging technologies) scientific visualisations have been discussed and therefore a broad range of discourses, various argumentation strands exist and there are no clear boundaries to other epistemic traditions (Burri and Dumit 2008, 298).

As this study takes science and its products themselves as sociological objects, this section offers a literature review of the STS perspectives on how scientific knowledge production, politics and technology are entangled with the social. The way scientific visualisations are analysed derives from deliberations that have been elaborated in Science and Technology Studies (STS) and the Social Studies of Scientific Knowledge (SSK) since *visual knowledge* (Beaulieu 2002) or the visual representation of data and knowledge can be considered as a special form of scientific knowledge. Communicating the results of the knowledge found is not only mediated by these visualisations, but also establishes these images themselves as performative actors into multiple contexts, while technologies play a crucial role. These assumptions build the basis of the present study and are explained in detail in the following.

Scientific knowledge is described as socially constructed, co-produced or symbolically interacted by different authors (e.g.: Jasanoff 2004a; Berger and Luckmann 1991; Bloor 1991; MacKenzie and Wajcman 1999 to only name a few). For the context of this study, it is important to understand that this knowledge is the referent that is being represented in the

visualisations analysed in this study or at minimum parts of this entity that is based on information and data, is being represented. In any case the result is a new form of scientific knowledge entering a new arena, is differently discussed and *performs* as a different actor than other common forms of representation that are traditionally textual.

Representation originally *"refers to an image inscription, or sign that depicts, signifies, or symbolizes something else"* (Lynch 2001, 16288) while visualisation is seen as a more dynamic term, referring *"to the practice of making images and the action of doing representing"* (ibid.). This differentiation is worthwhile as it is important to acknowledge that the process of *representing* inherently means skipping details, shaping focus, taking pragmatic decisions, but also following implicit or explicit rules of visual production: those of the visualisation technology, those of the research group and its working culture, those of the societal context(s) it is made, and those of the social context deployment is anticipated to perform in and according to design conventions. In other words "*Visual representation do not simply resemble natural objects: they express normative assumptions about natural and cultural worlds; they incorporate historically and culturally specific artistic conventions; and they mediate political and cultural relations of patronage, commodity exchange, and subjugation.*" (Lynch 2001, 16288, cf. e.g. Haraway 1997).

Yet these cultural and normative aspects are often ignored. According to Baigrie pictorial representations in science have to be distinguished from other forms of representation: *"…if visual depictions are considered at all, they are typically subsumed under the general philosophical concept of 'representation' – a concept that speaks to a wide variety of scientific activities. What distinguishes pictorial devices as resources for doing science, and the special problems that are raised by the mere presence of visual elements in scientific treatises, tend to be eclipsed by philosophical worries about the nature of representation."* (Baigrie 1996, xviii). This was already found by Gould in 1991: *"Scientific illustrations are not frills or summaries; they are foci for modes of thought"* (Gould 1991).

This study analyses the nature of representations in the field of scientometrics; trying to grasp how images are based on meta-data and rather abstract concepts of scientific outputs, how they transport meaning and how visualisations are performative in similar or different ways compared to images in other scientific communities as treated in previous studies by fellow STS researchers (for instance Beaulieu 2002; Joyce 2005; Prasad 2005; Mayer 2011b; Dumit 1999; Burri 2008a; Latour 1995; Lynch 1991). Topper provides a useful step *Towards an Epistemology of Scientific Illustration* (Topper 1996).

In their text Burri and Dumit offer an analytical grid by focussing on three different (not clearly distinguishable) dimensions of scientific imaging: the epistemic practices of the production,

the interpretation of the visual product or manifestation of data or knowledge and the use of scientific images within other social worlds and contexts (Burri and Dumit 2008, 298). For this study only the two last steps (engagement and deployment) are in focus; observing how images and visualisations within scientometrics are imposed, discussed, perceived and interpreted at a central conference in the discipline of study – to describe and conclude on their *performativity* within their own scientific community (Law 2009). In the following section the steps of production, engagement, and deployment as well as implications for performativity of visualisations are discussed theoretically in more detail. The co-production of representation and referent and the inseparability of knowledge and its production (cf. Mayer 2011a, 48) might make the structure of the following sections seem strange, but as the present analysis takes a standpoint of the performativity of visualisations, production issues do matter, but are not the object of observation, but their prerequisite.

2.3.1. Production

The usage of scientific images cannot be understood without its modes and processes of production as it shapes and determines ways and modes of presentation. On the contrary, presentation practices are being changed given the different production technologies and presentation needs feeding back to visualisation technology development.

Although the focus of this study lies on the deployment phase of the "image life-cycle" it is necessary to understand decisions and processes that takes place during production. In order to analyse how scientific images are created and designed at first hand, it is necessary to gain an idea of how they are created and what production features seem to be important to this specific community, yielding a whole lot of problems concerning aesthetics, features, sizes, style constraints, medium of exposure, etc. (cf. Pauwels 2006b, 15). Incisive work in this area often comes from the area of medical imaging technology as for instance discussed by Prasad and Joyce both dealing with magnetic resonance imaging or Beaulieu comparing the same with positron emission tomography (PET) scans as well as Dumit who transfers the issues to the law court (e.g.: Prasad 2005; Joyce 2005; Beaulieu 2002; Dumit 1999).

A series of concepts crucial to the production process of visualisations introduced and described by Latour in his "photo-philosophical montage" (Latour 1995) are considered useful in the context of this study, as he explains how *intermediaries* shape the pathways of information "travelling" from the *referent* to the sign (Latour 1995, 155). In this transformation process two directional effects can be observed: one of *reduction* and one of *amplification.* For this analysis is not intended to analyse each step and intermediary influencing the production process of the scientific images, but it helps to understand how processes that lead to an eventual (re)presentation as performed at the ISSI conference are eventually

shaped as already applied earlier in chapter 2.2. As Latour points out, that this transformation process can theoretically be reconstructed in both directions, it might be possible to draw modest conclusions on what layers (e.g.: modes of data processing), intermediaries (self-censuring, internal institutional hierarchies,…) or processes of reduction/amplification affect the pictures that are presented in the context of this case study.

Amann and Knorr-Cetina describe the production of images as an interactively negotiated process in which (proto-)data is being selected and transformed in order to *fixate* belief. "*Nearly all published images are carefully edited montages* [original emphasis] *assembled form fragments of other images*" (Amann and Knorr-Cetina 1988, 160). Daston and Galison describe how the notion of objectivity changed historically through and with imaging technologies (Daston and Galison 1992).

Technology plays a crucial role within the negotiation processes of scientific image production. These sociotechnical negotiations consist of processes demand formalisation and transformation (cf. Lynch and Woolgar 1990) and implies a complex interaction between human and nonhuman *actants*. "*Like all artifacts, scientific images and visualizations are constructed by combinations of machines and people using concepts, instruments, standards and styles of practice."* (Burri and Dumit 2008, 301). The role of these machines has also been described by Suchman as follows: *"First that it is through these devices that the regularity, reproducibility and objectivity both of phenomena and of the method by which they are found are established. Second, that representational devices have a systematic but necessarily contingent and ad hoc relation to scientific practices. And third, that representational technologies are central to how scientific work gets done."* (Suchman 1988, 305).

In the field of scientometrics visualisation tools have become increasingly present. Starting from simple data graphs used in many scientific disciplines, there is also a rising range of more complex visualisation types like network graphs, many of which are free and open source tools. A thorough description of the role of computational understanding of data with visualisations in the field of physics, including inter-disciplinary interactions, has been elaborated by Galison. Here the problems with the epistemic status of images are discussed in detail (Galison 1997).

Talking about image production as practice, we find it inherently *situated* in the sense, that it is always acted in some epistemic but also social and cultural context: *"…we must understand* [representations] *in relation to, as the product of and resource for, situated practice. Just as instructions presuppose the work of "carrying them out," so representational devices assume the local practice of their production and use."* (Suchman 1988, 322).

While in different disciplines, different *methods of structuring perception* are deployed, it was found that in parallel, this visual imagination is also disciplined itself by doing images (e.g.: Gooding 2004). Imagination and the physical perceptual process are described as also only one aspect of the whole practice of visualisation: *"…"visualization" – materializing, imaging, illustrating, depicting, referencing, indexing, and demonstrating – cannot be reduced to perceptual processes."* (Lynch 2006, 26).

Visualisation production seen as technology and can be understood as socially constructed (W. Bijker and Law 1994; W. E. Bijker, Hughes, and Pinch 1989; MacKenzie and Wajcman 1999). This would mean that while designing a technological artefact, the designer inevitably inscribes ideas about society. Thought the other way round, technological artefacts in turn are manifestations of the social. In Jasanoff's words *"science and society, in a word, are co-produced, each underwriting the other's existence*" (Jasanoff 2004b, 17).

Analysis of different types and modes of visualisation according to their aesthetics and utility, design issues or arrangement logics in recent and historic scientific communications has been elaborated exhaustively by others, most prominently Tufte (cf. Tufte 1983; Tufte 1997; Tufte 2001; Tufte 2006; Kress and Leeuwen 2006). Here also makes considerations of cognitive sciences on image perception as well as descriptions of what types of design strategies are better in which cases of application are included.

2.3.2. Engagement

The phase of engagement focuses on the *instrumental* role of images, meaning their ways and forms of usage and applications, their discussion and their means of *representation*. *"Engagement analysis treats each visual form as an actor in its own right, actively involved in the doing of science."* (Burri and Dumit 2008, 302). Technologies do also play a forming role in the way visualisations are instrumentalised in order to make data *meaningful*: depending on visualisation, presentation or media technologies, imaging practices or application might change. As stated by Bastide for the usage of images in texts: "*There is therefore a double movement from the figure to the text and from the text to the figure: the figure* […] *validates the experimental protocol; the text, explaining how to read the figure, gives it its meaning."* (Bastide 1990, 193). The embedding of a visualisation in a slide show as well as a different social setting makes the described movements become even more complex. It is also the epistemic as well as spatial environment that shapes certain standards of what is expected from a convincing scientific visualisation.

Derived from linguistic anthropology in the nineteen sixties when Austin concluded that all utterances are performative and so do the realities of what they want to inform about (Austin 1962), the concept of performativity as an inherent quality to lingual and other enacted

expressions to *perform* a type of being was shaped (Hall 1999, 1984). As already discussed in chapter 2.3 to some detail, the way performativity is understood here is more related to the sum of actions and processes that shape the real for a certain moment in time. Conceptualised for the present work, this central notion shall be the guiding idea for analysis by ascribing certain performativity to scientific visualisations.

With the claim "*that representations are not more or less clear windows on reality, but shape, form and diffract reality*" (Law 2009, 5), Law positions visualisations as one element of assemblages *doing* realities. Those realities become enacted by *practices* of putting objects, subjects, materials and meanings into relations. These practices are defined as *"detectable and somewhat ordered sets of material-semiotic relations"* that shape *collateral realities* that are being *done* incidentally and unintentionally (Law 2009, 1). For the sake of this study the notion of performativity is used to understand how realties are enacted at a conference setting. Similar to Law's way of approaching his field at a project meeting, analysing performativity of slide show presentations, the following descriptive passage shapes the underlying understanding of approaching the field for the present study:

"*…most of the relations assembled to do the meeting and its various realities were either designed elsewhere (think of the electricity supply, a crucial but unspoken component in the relations that made the meeting, or the computer software), or they happened anyway independently of intention. Think, for instance, of the bodies of the speakers; their clothes; the common language (English); the time-coordination; the conventions (timeslots, talks, questions and answers, breaks and all the rest) within which the meeting was structured and ordered. Here's the point. All of these were a part of the ordering of the Berlin meeting. All participated in the realities enacted there. None could be easily have been wished away. An attempt to do something different, very different, might have been possible but it would not have been trivial. Enacting realities is not a trivial matter."* (Law 2009, 13)

Performativity has also been treated in the context of geographic studies, which is interesting since this study also treats maps in form of science maps and network graphs layered on cartographic maps. Turnbull explains the conceptualisation of performativity in this context as follows: "*…performance of knowledge practices and their attendant knowledge spaces and artefacts simultaneously structure and shape our socio-cultural world in a process of coproduction.*" (Turnbull 2007, 142; see also MacKenzie 2003)

Law and Singleton state a turn in different STS and feminist technoscience strands towards performativity (Law and Singleton 2000, 767) and describe how understanding technologies as performative changes what we see: "*The turn to performance is sometimes seen as constructivist, but it has particular implications. It suggests that technologies, knowledges,*

and working may be understood as the effects of materially, socially, and conceptually hybrid performances. In these performances different elements assemble together and act in certain ways to produce specific consequences." (Law and Singleton 2000, 774)

"*...the success of any performance is uncertain and that anomalous performances tend to fail because they find that they cannot easily recruit the right actors. Thus new performances interact with enactments of older performances – to mimic and reaffirm them, or perhaps to interfere with them and suggest alternatives.*" (Law and Singleton 2000, 774)

Following the thought of Edwards and others (Edwards et al. 2011) the increased need for interoperable data, tools and services results in an increased need for 'data about data' – i.e. *meta-data* which is very much the case in bibliometrics. The authors examine this meta-data by focusing "*on its role in an ephemeral process of scientific communication*" (Edwards et al. 2011, 673) regarding meta-data itself as a powerful process in scientific knowledge production. The above mentioned processes in scientometrics do not only describe the translation from meta-data to visualisations, but can also be examined for the performativity of meta-data itself in communication processes within the discipline, but also outside. How scientific knowledge transgresses the divides between these inside and outside worlds has been described with manifold concepts in science and technology studies, like *immutable mobiles* (Latour 1986) or *boundary objects* (Star and Griesemer 1989).

Visualisations are a means of transport for scientific arguments researchers try to make allies with, as described by the term of **immutable mobiles** coined by Latour. In his sense, scientific visualisations are mobile, as they are easily transferable to different situations, but are immutable at the same time, as they are intended to stabilise some meaning or scientific knowledge (Latour 1986, 7). Especially during a scientific conference setting, it could be expected to observe visualisations as utilised in a way that makes them immutable mobiles, as scientists try to get their argument across to their fellow researchers.

Understanding scientific visualisations as immutable mobiles can give precious insights in how they on the one hand shape a field as boundary objects, but on the other hand how they can transcend disciplinary boundaries and act performative as different representation kinds. By becoming *mobile*, they are *immutable* since they are casted in standardised shapes in order to be movable, equally they are made *flat* as the world is tamed on a map (even 3D animated visualisations eventually become plots when they are deployed in conference papers) and the *scale* of the inscriptions are being *modified* following the scientist's command to *domesticate* what would be too big or too small to become tangible or *handle*-able. These advantages are all pressed home when visualisations are deployed, but there are even more: once produced immutable mobiles and visualisations respectively become

reproducible effortless comparably, become *re-combinable* and are *superimposed* in different layers and are eventually *made part of written text* and *merged with geometry*, meaning that any three-dimensional object can be measured and translated into diagrams and numbers. Details on *inscriptions* becoming *immutable mobiles* are elaborated in Latour's *Drawing Things Together* (Latour 1986, 19f.). He argues how eventually these abstractions to reality become political by the way they are treated by actants in power relations: "*By working on papers alone, on fragile inscriptions which are immensely less than the things from which they are extracted, it is still possible to dominate all things, and all people*." (Latour 1986, 30).

Having a visualisation engaged and deployed, efforts have to be taken to keep it performing in a desirable way, as Lynch states: *"'immutable mobiles' depend upon incessant efforts to control sources of distortion, disruption, and misinterpretation at every point of production and distribution"* (Lynch 2001, 16289).

While contemporary claims for accountability and therewith packaging scientific results in a vastly simplified set of numbers and indicators and standardised indexes, *mobility* is treated as an asset to be aspired to allowing objects to be transported over a long distance and convey unchanging information. In the sense of Latour's immutable mobiles, the mobility of scientific "knowledge-objects" (Stöckelová 2012, 289) is highly emphasised – although not without criticism – while their immutability can be sacrificed: "*Scientific knowledge-objects are taken up by other networks and actors, and thus changed to fit their agendas.*"(Stöckelová 2012, 290). This effect is suspected to be happening when visualisations in scientometrics transcend scientific arenas or different public spheres and become instrumentalised in policy processes. But this is not the subject of this study, since it was not the objects that were followed while travelling (cf. Czarniawska-Joerges 2007) to understand its *transformations*, *transmutations* and *translations* from referent to representation or its role in this process to stabilise *coherence* and *continuity* of what has already been *known* (Latour 1995, 58). It cannot either be observed how the visualisations as objects are assigned power as an actant within complex networks. What we have in this study is a small window in time and space to observe the whole networks at stake but not easily being able to deconstruct these networks to examine its actors and actants and the power-relations in between. Yet their *performativity* itself was visible and shaping not only the conference, but produced and enacted *collateral realities* exceeding the conference time and space in any direction.

In the sense of Gieryn's boundary work (Gieryn 1999), as also applied by Burri, the role of this performativity towards the disciplinary boundaries and therefore visualisations themselves acting as **boundary objects** was hoped to be observable with this study (Burri 2008b, 36). Having already conducted a similar ethnographic studies at scientific

conferences, Burri is describing how the emergence of MRT images has changed the field of radiology (Burri 2008b) with the imaging technology being a central actant of this development. As the field of scientometrics is a rather heterogeneous, trans-disciplinary one, the images presented can take roles as *boundary objects* and transcend the boarders of their field or at the same time contribute to shaping it. "*Boundary objects are objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual use"* (Star and Griesemer 1989, 393). It was decided to use the concept of boundary object, since it focuses morae on the operationalisation of objects to transcend disciplinary or social borders, whereas immutable mobiles inhere both, the mobility and a certain immutability, which – in this case – might be contestable. A scientific visualisation travelling between different public spheres or *transepistemic arenas* (Knorr-Cetina 1982). And eventually, "*for us as scholars, scientific publications <u>are</u> boundary objects which are also obligatory passage points!"* (Star and Griesemer 1989, 396) makes the concept particularly interesting to the field of scientometrics.

2.3.3. Deployment

Finally the scope of analysis can turn to how scientific images arrive in different social settings. Analysing what role these kinds of "expert images" of the brain can play in other socio-cultural spheres uses the term of acculturation to describe the phenomenon of how different types groups perceive and interpret these images differently, how they are trained, socialised or simply get used to image application (Dumit 1999, 180). Lynch deals with representations of theory concepts in the social sciences and is one of very few in his field (Lynch 1991) as Mayer does by observing scientists creating node-edge diagrams in social network analysis processes (Mayer 2011b).

Considering Pauwel, when he says that *"…the use to which a representation is being put constructs its representational status, at least in part"* (Pauwels 2006b, 5), the different deployment occasions for visualisations in scientometrics must have some effect to their performativity. The present case looks at how visualisations are deployed in a conference setting, which are often derived from an analyst's report, a scientific publication or are screen-shots from interactive visualisation tools and therefore being created for a completely different deployment setting.

Talking in the terms of Amann and Knorr-Cetina, representations are transformed data *montages* that turn into evidence and eventually persuade their "readers" towards an argument (Amann and Knorr-Cetina 1988). This opens broad space for interpretation, based

on their persuasive power as well as their *mutability* or, how Burri and Dumit coin it: "*On the one hand, scientific images' persuasiveness depends on their being regards as the simultaneous voice of technoscientific authority and as expressions of nature. On the other hand, the semiotic openness of images leaves many openings for contesting their menacing and calling into question their objective authority"* (Burri and Dumit 2008, 305). What this kind of "nature" can be in the context of scientometrics, measuring dynamics of "a science" that is only very partially mirrored in scientific citation databases and therefore is a very abstract, and eventually political one, leading to the general standpoint, that scientific images can be seen as technological objects with their own role in the *co-production* of science and societal entities (cf. Jasanoff 2004a). In order to set all these reflections into a bigger context of the social construction of scientific knowledge, it is worthwhile to go into detail on how scientific knowledge is created in general and then turn to the specific kind of knowledge(s) enacted in visual representations (cf. Jasanoff 2004a; Berger and Luckmann 1991; Stoetzler and Yuval-Davis 2002; Stehr and Grundmann 2005; Baigrie 1996; Bloor 1991 etc.).

None of the mentioned empirical studies in visualisations have ever dealt with the discipline of scientometrics, so this work can be aligned as another element of understanding science visualisations' performativity like the studies of Law, Burri, Galison or Latour who were looking at disciplines or multi-disciplinary project environments like radiology, physics, animal welfare or pedology (Law 2009; Burri 2008b; Latour 1995; Galison 1997, amongst others). The starting point of analysis for the present study shall be the point where Amann's and Knorr-Cetina's study ends, namely with an outlook on what happens after the *fixation of (visual) evidence* when it "*is inspected by the wider audience in a specialty field*" (Amann and Knorr-Cetina 1988, 164).

3. How are Visualisations in Scientometrics Performative?

Based on the two notions of *engagement*, meaning the instrumentalisation of scientific visualisations, as well as *deployment* (Burri and Dumit 2008) towards *performativity* (Law 2009) within different social contexts, visualisations are analysed, leading to the following main guiding question complex:

How are visualisations in scientometrics performative in enacting realities and how are they boundary objects in both manifesting and changing how scientific knowledge is being created?

To understand the dimensions of these questions it was considered useful to treat it by focussing on a certain case. For this sake the ISSI conference 2013 was selected and taken for phenomenological observation. Narrowed down to the case study, the consequent observation-leading question would be the following: How are visualisations of scientometric data being engaged and deployed at the ISSI conference 2013 in Vienna? How are they performative? How do they become boundary objects and with what effects?

In the field, a set of sub-questions was utilised to steer the observation foci, based on the above discussed concepts. These questions were then transformed to build the basis of the analysis scheme for the field notes as described in 4.3.1.

The guiding question complex was de-composed to be treated within three main aspects: understanding visualisations as 1) social technology, 2) as transportable objects, and 3) as actants.

3.1. Visualisation as Social Technology

This aspect of observation opens a complex of questions on technical aspects of visualisation as a craft. It was focused for example on the different kinds of visualisation (see Pauwels for a theoretical framework on representation types; Pauwels 2006b), in the sense of their technical production and issues in this respect, different representation means and processes, spatial issues in a technical sense or differences in sessions and presentations. Questions on the content or underlying ‘data quality’ or ‘accuracy’, aesthetics, the usage symbols or arrangement (Kress and Leeuwen 2006; Tufte 1997) are treated only marginally - it rather focuses on how imageability is constructed, in the sense of how it is decided what data is worth being presented visually (K. Lynch 1960; Vertesi 2008; Vertesi 2012), and on how this construction is socially shaped (W. E. Bijker, Hughes, and Pinch 1989). The social setting of a scientific conference as a specific space is an interesting opportunity for understanding these socially constructed technologies and their results in action.

3.2. Visualisation as Transportable Object

The second aspect of analysis turns to the engagement of visual objects. It poses questions towards the purposes, audiences, different spaces and functions of these visualisations that are mostly representations of meta-data, again representing something else. How can these specific images become transportable over the different usage purposes and social spaces they are engaged in? This aspect asks how meaning is inscribed and described (Akrich 1992), what negotiation work is necessary to enable a common vision of the referent being presented (Latour 1995). Prevailing metaphors and stories and their roles are tried to be

grasped (cf. Burri and Dumit 2008; Mayer 2011b). We discuss the role of epistemic standards (Knorr-Cetina 1982) of the scientometrics community that may become visible through visualisations. As discussed in the previous chapters, it is interesting in how far visualisations in scientometrics become immutable mobiles (Latour 1986), but the focus of this study rather remains on visualisations as boundary objects between transepistemic arenas (Knorr-Cetina 1982). Again, spatial issues (Beaulieu 2010) play a role – in this aspect in the sense of social spaces rather than the physical place and settings that matter more in the previous aspect.

3.3. Visualisation as Actant

As a third strand of analysis visualisations are understood as actants in their own discussion. Focus is laid on the performativity of the shown representations and how they contribute to enact realities collaboratively (Law 2009; Law and Singleton 2000). To understand the complex networks visualisations perform in, questions arise about who the actors and actants are within the discussion and what roles they play. What aspects of the images are discussed at all and which ones are taken for granted and not questioned? What implicit or explicit ideas (Collins 1974; Stover 2004) about how the performativity (Law and Singleton 2000; Law 2009) of their images are stated or communicated by the presenters? What impact do the spatial (Beaulieu 2010) and social settings of the conference (venue) have to what is being discussed and how these issues are discussed (or not)? Is the image itself recognised as actant in the discussion at all or does it serve *invisibly* as a means for discussing the underlying data? How is the picture performing with relation to spoken and written words in the presentations?

Compared to the second aspect of visualisations as transportable objects, where it is observed, how the images themselves have to change when transcending boarders, in the third strand it is discussed, how the network these images are performing in is changing and what realities are being manifested or re-enacted.

4. Research Conduct

To address the set of questions posed above, a mainly qualitative, phenomenological, approach was chosen. Based on this epistemic environment the main theoretical concepts applied in this study as outlined in chapters 2 and 3, chapter 4 discusses methodological choices made. In 4.1 the scope of the case study is set and the framework of observation defined. Methodological reflections are discussed in chapters 4.2 and 4.3, describing the

steps of data retrieval and analysis. Through participant observation in this project, it is attempted to gain insight into the most important methods, discussion, habits and arguments within the state of the art of scientometric research and how its results are presented – with focus on the application and *performativity* of visualisations (cf. Law 2009). The data gathered is analysed to feed into a small ethnographic field study on the scientometric community to discuss the role of scientific representations within this very community. To choose the panels of observation, a content analysis of the conference abstracts was conducted; to sample the most promising sessions in terms of analysing the performativity of the presented visualisations and how they are discussed. During the conference and between participant observations of the presentations and discussions it was possible to conduct a couple of qualitative ethnographic interviews to confirm, broaden or sometimes correct the insights obtained from observing. Additionally some of the slide shows including the pictures and visualisations analysed were shared by the conference attendees and it was possible to take photos of other examples of visualisations “in action”. In the aftermath, the field notes were digitalised and contextualised before further analysis was undertaken as a next step.

The methodology chapter concludes with critical reflections on the possibilities and limitations of this research set-up in chapter 4.4.

4.1. Scope of the Study

Declaring the ISSI conference to be a case is central to the design of this study. All measures were focused on the couple of conference days and processes connected to it (e.g.: organising the conference and talking to the organisers about the preparation phase). This framing on the one hand allows concentrating on local performative actions, but on the other hand possibly factors out other decisive dynamics in the field of scientometrics that are not visible with the narrow approach at stake.

Panels and Sessions

The sessions were organised around three panels a day, one in the morning and two in the afternoon. Each session presented 4 conference papers with again 4 sessions in parallel in one panel. The structure of the organised conference resembled many others visited within the past couple of years, in the way time was planned meticulously with straight schedule and strict sequences of speakers, with several panels happening in parallel. As described in detail in 5.2, the framing of how to approach the sessions was to some extent a pragmatic solution.

Visualisation Types

The presentations that were observed used a broad range of types of visualisation, as listed below. This list is neither exhaustive nor are its items exclusive categories (meaning that some visualisations in this study can fit in more than one of the items), but it gives a rough overview of the diversity at stake.

- Simple tables that exceed the standard formatting by graphically highlighting or emphasising certain elements (e.g.: Figure 4)
- Simple bar and line charts representing figures or comparing sets of figures (e.g.: Figure 5 and Figure 6)
- Radar charts (e.g.: Figure 7)
- Scatterplot graphs (e.g.: Figure 8)
- Dendrograms (e.g.: Figure 9)
- All kind of “mappings” and maps arranging data and conceptual elements in relation to each other as well as heat or density maps (e.g.: Figure 10, Figure 11 and Figure 12)
- Flow charts (e.g.: Figure 13)
- Graphic representations of theory concepts or methodological processes (e.g.: Figure 14 and Figure 15)
- Alluvial diagrams (e.g.: Figure 16)
- geographic map-based diagrams like cartograms (e.g.: Figure 17)
- bi- and multi-modal network visualisations (e.g.: Figure 18 and Figure 19)
- screenshots of the user interfaces of the visualisation tools used (e.g.: Figure 20 and Figure 21)
- drawings, illustrations and cartoons (e.g.: Figure 28, Figure 29 or Figure 31)

Most of the speakers used a combination of several forms – either by utilising different variations of one type of visualisation or used other types for explaining the creation of the first or other data aspects. Most of the images printed in the conference proceedings and in the presentations were in colour. What fell into the realm of this study, were more complex ways of visualisations to understand how their meaning is being ascribed and decoded. Yet the more common graphs less rich in data they represent are valuable tools for understanding the performativity of visual data as well, therefore they were kept in the analysis.

Most of the visualisation types as listed above are representations of some figures and data or theory concepts rather than of some *natural* phenomenon (cf. Pauwels 2006b). In the following section a brief description of the different visualisation types as listed above is provided. All examples include their original labels as taken from the conference proceedings publication. The simplest shape for arranging data is by line and row, shaping a table. Some tables had graphically highlighted elements, exceeding the standard formatting of content organised in line and row. Although one might argue that tables are rather on the textual side of the boundary between a visualisation and a textual representation, the arrangement of

data according to style structures can also be regarded as a simple mapping – in the case of Figure 4 along a time-line (per year).

Table 3. SIGIR Conference sessions from 2008-2011

2008	*2009*	*2010*	*2011*
User Interaction Models	Novel search features	Clustering	Query Analysis
Web Search	***Classification and clustering***	User Model	Learning to Rank
Evaluation	Expansion and feedback	Applications	Retrieval models
Collaborative Filtering	**Web 2.0**	Search Engine Architectures and Scalability	**Social Media**
Learning to Rank	Retrieval models	***Link Analysis & Advertising***	**Web IR**
High-Performance & High Dimensional Indexing	Speech and linguistic processing	Learning to Rank	Collaborative filtering
User Adaptation & Personalization	Recommenders	Filtering and Recommendation	Query Analysis
Clustering	Question answering	Information Retrieval Theory	Communities
Multilingual & Crosslingual Retrieval	Efficiency	Language Models & IR Theory	Image Search
Relevance Feedback	**Web retrieval**	Query Representations & Reformulations	Web Queries
Summarization	Learning to Rank	***Automatic Classification***	Collaborative filtering
Exploratory Search & Filtering	Information extraction	Retrieval Models and Ranking	Multimedia IR
Multimedia Retrieval	Clickthrough models	User Feedback & User Models	Summarization
Query Analysis & Models	Vertical search	**Web IR and Social Media Search**	Query suggestions
Non-Topicality	Interactive search	Document Structure & Adversarial Information Retrieval	Linguistic Analysis
Probabilistic Models	Multimedia	Users and Interactive IR	Effectiveness
Analysis of Social Networks	Federated, distributed search	Document Representation and Content Analysis	Multilingual IR
Question-Answering	Industry Track speakers	Test-Collections	Recommender systems
Social Tagging	Evaluation and measurement	Query Log Analysis	Test collections
Content Analysis	Query formulation	Summarization & User Feedback	
Learning Models for IR	Spamming	Query Analysis	
Text Classification		Effectiveness Measures	
		Multimedia Information Retrieval	
		Non-English IR & Evaluation	

Figure 4: Example of a table with graphical elements; source: Gorraiz et al. 2013a, 1318[6]

The second most commonly used type of diagram were s*imple* bar and line charts representing figures or comparing sets of figures. Telling from the very familiar colouring, most of them were created with the help of the most widely used spread sheet software.

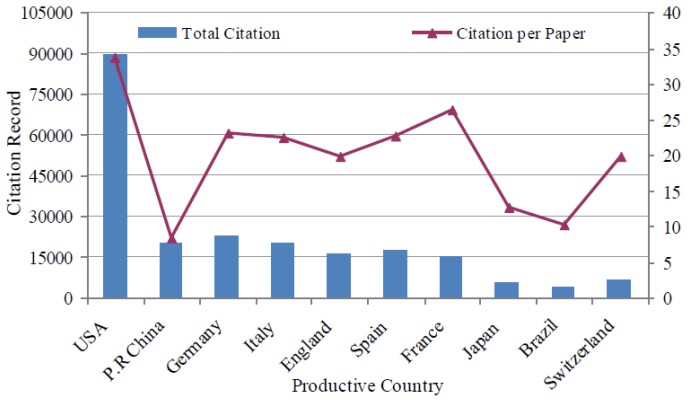


Figure 6. Citation distribution of global SCI&SSCI papers

Figure 5: Example of a bar- and line chart; source: Gorraiz et al. 2013b, 838

[6] All references to Gorraiz et al. 2013 are pointing to certain papers published in the conference proceedings books (Vol. I and II) of the ISSI conference 2013 with Gorraiz et al. as their editors – not as the visualisation producers. Since ethnographic data was widely anonymised for this study it was avoided that source references lead to the actual owners and producers of the visualisations as image quotes, which shall not be taken as a negligence of their intellectual property. Same counts for presentation slides provided by the authors and presenters that where only labelled as sourcing from "one author". Exact source reference can be provided by the author of this study upon request.

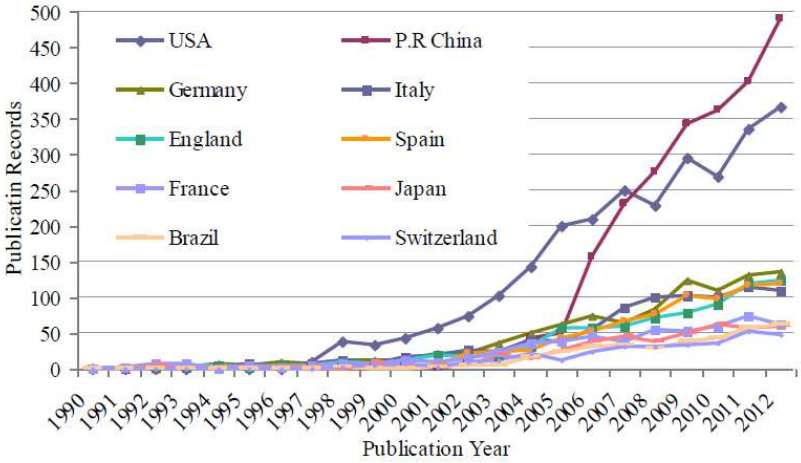


Figure 5. Annual country record distribution in the complex networks study

Figure 6: Example of a line chart; source: Gorraiz et al. 2013b, 837

Figure 5 and Figure 6 show examples of line and bar charts representing data – in these cases figures per different countries and years. The logics for these visualisations are highly present in many different occasions and the referents for them are abstract figures. Lynch puts it as the following: *"Graphs, chart recordings and digital images are public communication devices. They have a material organization on their own, and are collectively discussed, reproduced, and worked over. The public accountability of what is shown or disclosed by such displays cannot be traced back to a private idea or a mental representation."* (Lynch 2006, 26).

When the different aspects compared were not possible to be arranged according to a linear logic, sometimes radar charts were used as for example in Figure 7.

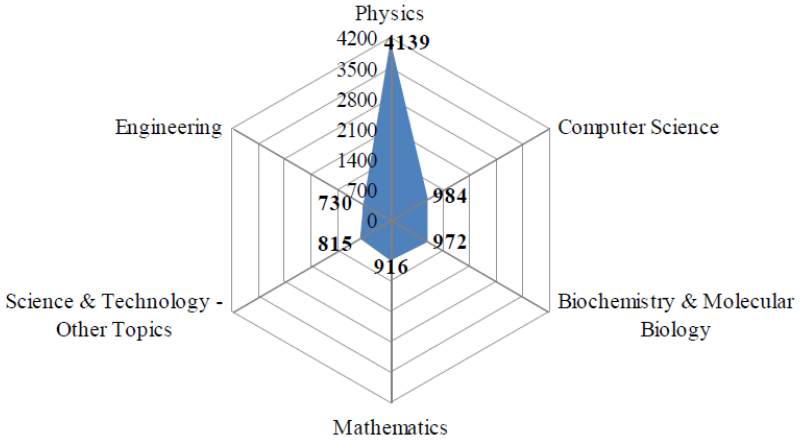


Figure 2. Subjects distribution of SCI&SSCI papers

Figure 7: Example of a radar chart; source: Gorraiz et al. 2013b, 835

Scatterplot graphs were used to visualise certain distributions to emphasise tendencies, as shown in Figure 8.

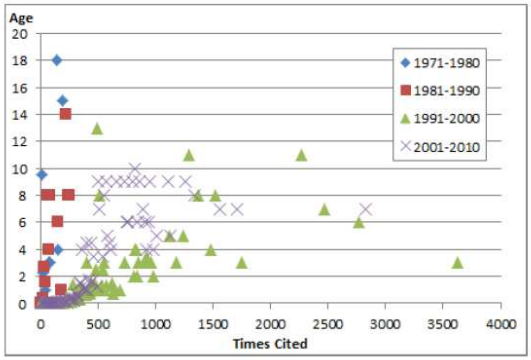


Figure 9 : Average Ages to the Highest Points (Averages are calculated for each 10 times cited.)

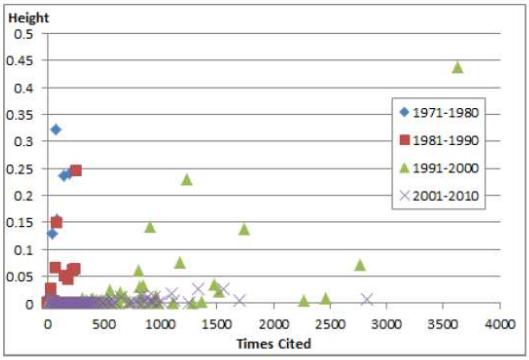


Figure 10 : Average Heights to the Highest Points (Averages are calculated for each 10 times cited.)

Figure 8: Examples of scatter plots; source: Gorraiz et al. 2013b, 516

Deriving from the greek root "d*endron"* (tree) and "*gramma"* (drawing) is a type of visualisation that structures elements hierarchically. Resembling stems and branches it carries the metaphorical name of tree diagram. Figure 9 shows an example of a dendrogram showing a hierarchical clustering of scientific journals.

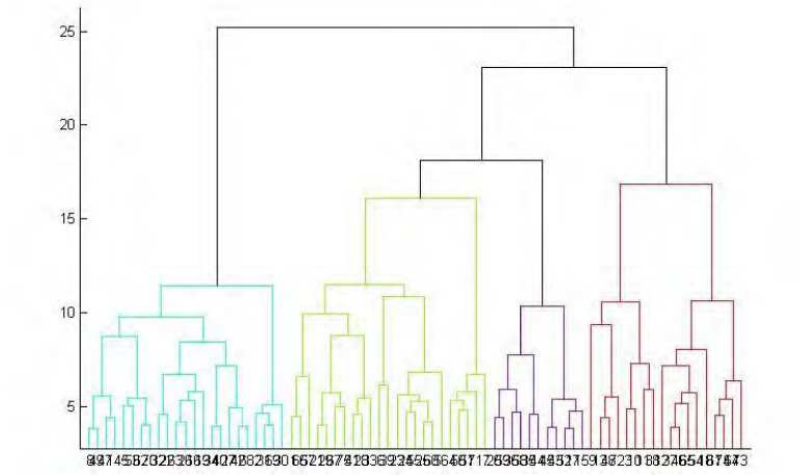


Figure 2. Dendrogram for hierarchical clustering of the 8272 journals based on Ward's method [Data sourced from Thomson Reuters Web of Knowledge]

Figure 9: Example of a dendrogramm, source: Gorraiz et al. 2013b, 240

Arranging elements in relation to each other can be done more precisely with all kind of "mappings", since not only static hierarchical relations, but different comparable aspects can be depicted (e.g.: relative size to each other depicting some kind of strength, relative position to each other and colouring, depicting groupings and clusters). Many different maps arranging data and conceptual elements in relation to each other as well as heat or density maps were shown at ISSI. Figure 10 is an example for spatially arranged elements (in this case it is authors according to their publication strength). Figure 11 takes a geographic relief

cartogram as a background for depicting “heights” in data. Figure 12 is an example for heat map, with different colour zones describing different “densities” in context of the underlying data.

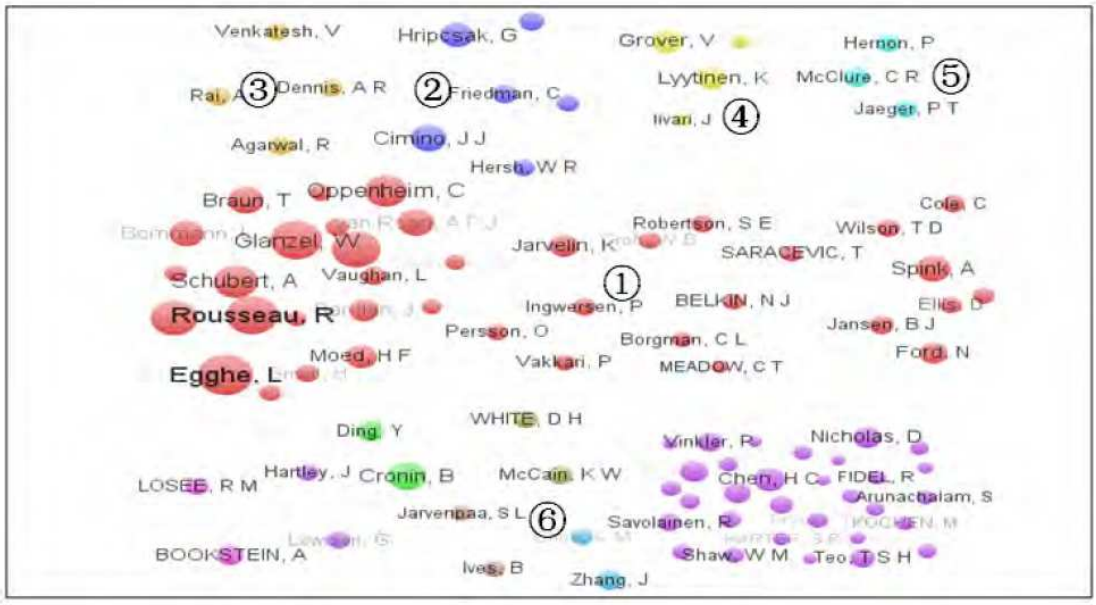


Figure 1. Mapping result of CA network

Figure 10: Example of a science map depicting publication strength per author; source: Gorraiz et al. 2013b, 343

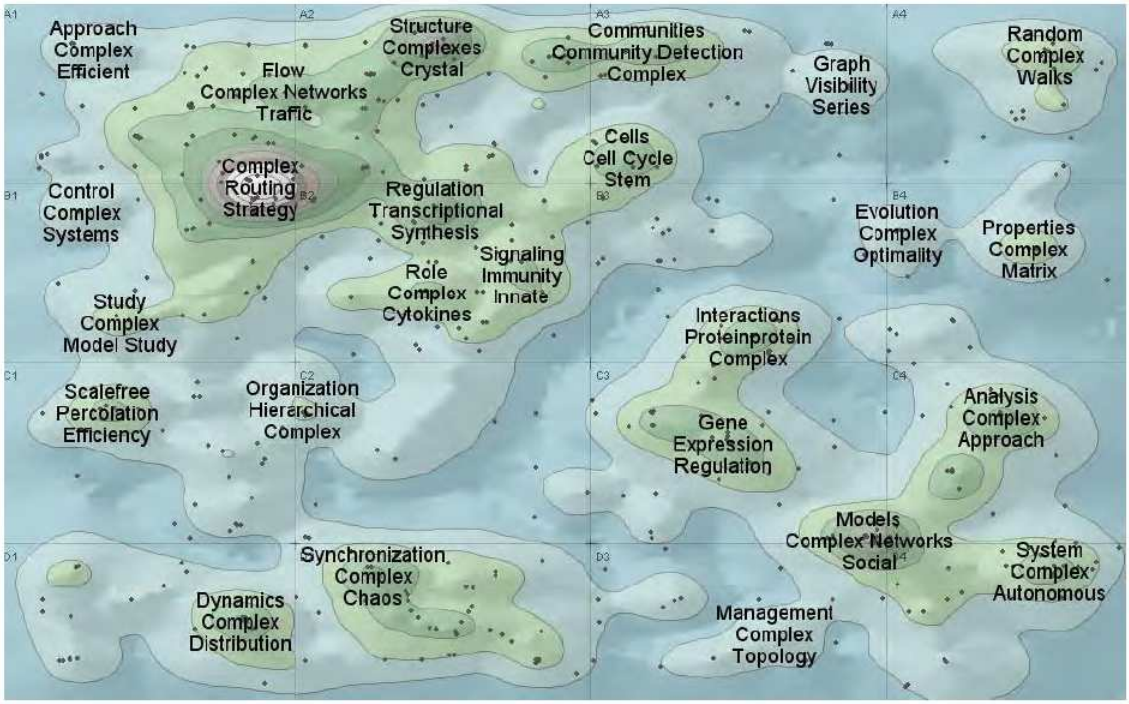


Figure 12. Cluster and co-words map of SCI&SSCI papers published

Figure 11: Example of a science map in the style of a geographic map; source: Gorraiz et al. 2013b, 842

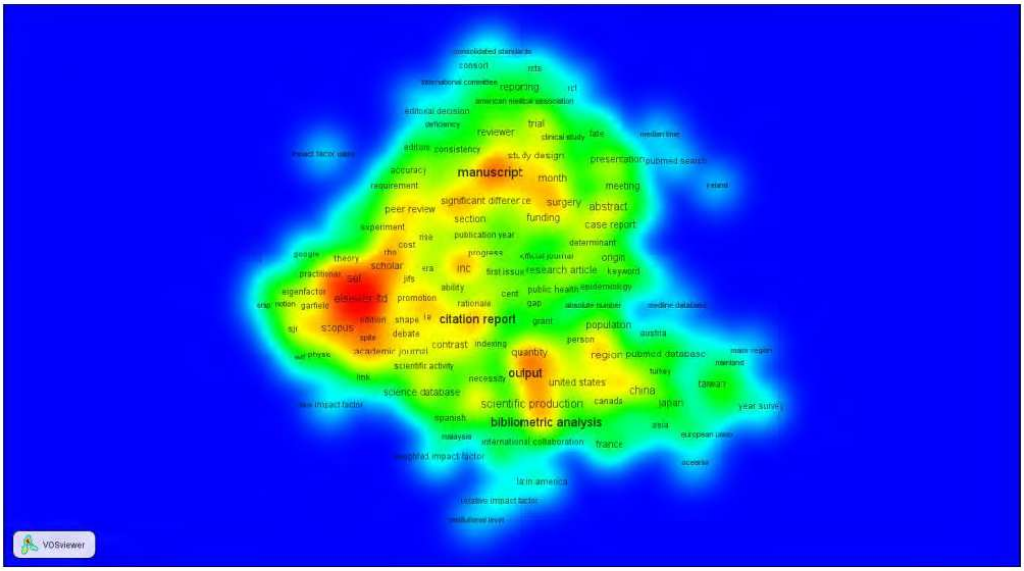


Figure 5: Density map of title and abstract words in output on JIFs, '06-'10 (based on VOS Viewer)

Figure 12: Example of a science map in the style of a density map; source: Gorraiz et al. 2013b, 74

Flow charts are chosen for depicting directed relations between theoretical elements, as shown in Figure 13 and also later in Figure 15. Text elements are shaped as boxes that create entities in a sequence, connected with arrows. Such depictions suggest dependency relations between different entities.

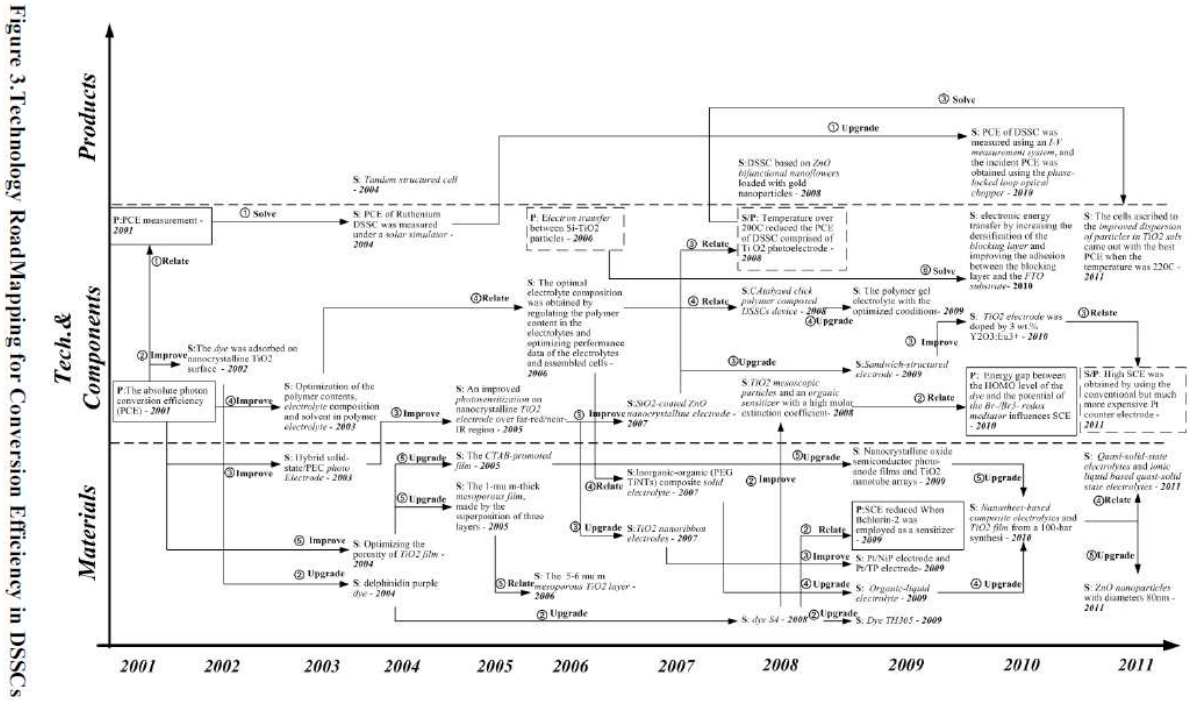


Figure 13: Example of a visualisation in a diagram using flow chart logic; source: Gorraiz et al. 2013b, 872

Graphic representations of theory concepts or methodological processes as opposed to referents consisting of figures were also highly popular. While they differed in terms of what kind of content was visualised, the shapes and forms resembled mathematical logic. "*Like many diagrams in theory texts, the figure is an assemblage of words, geometric shapes, and vectors.*" (Lynch 1991, 6). Figure 14 shows a methodological process put into eclipses and arrows. Figure 15 shows a methodological work flow in shape of a flow chart.

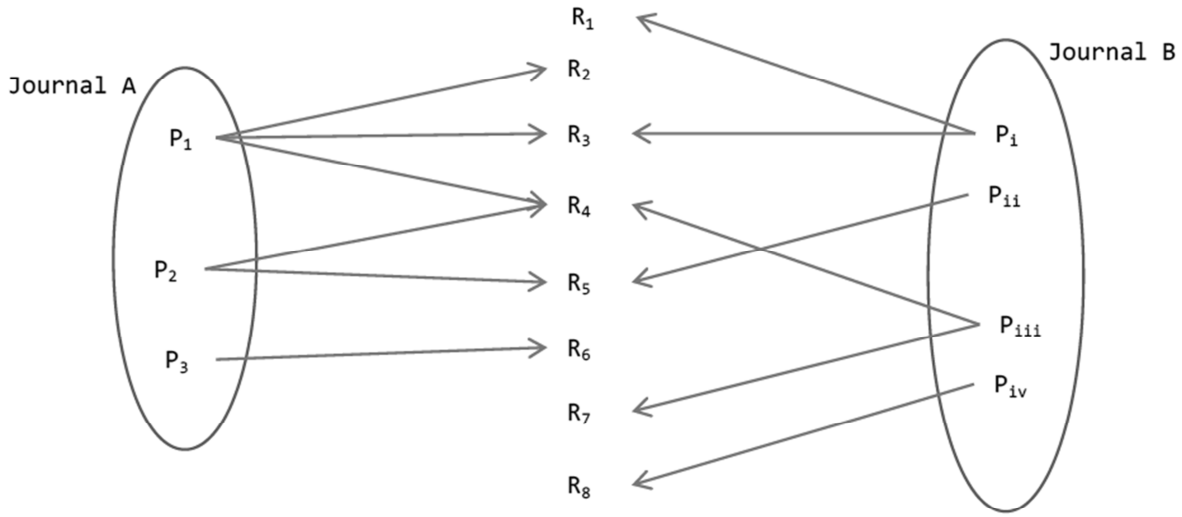


Figure 1. Graphic representation of bibliographic coupling between journals

Figure 14: Example of a graphical representation of a methodological concept; source: Gorraiz et al. 2013b, 239

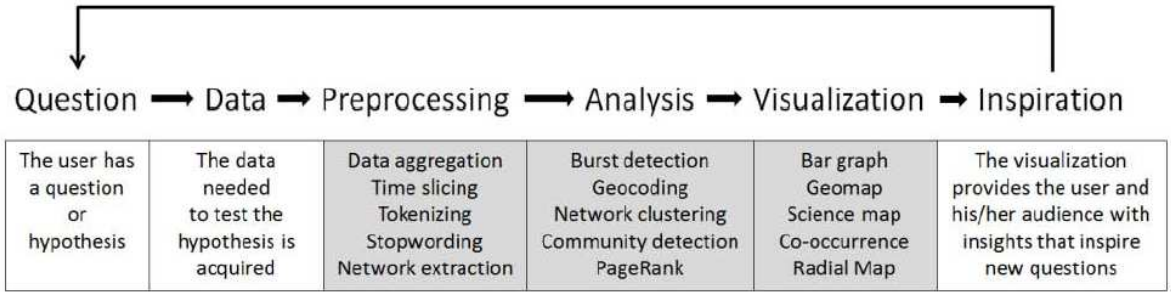


Figure 2: General Sci2-based visualization creation workflow (tool-specific tasks in gray).

Figure 15: Example of a flow chart describing a methodological process; source: Gorraiz et al. 2013a, 1346

Alluvial diagrams have the capacity to depict how entities change over time and were also imported from the natural sciences in the case of Figure 16 to depict developments of how research fields change.

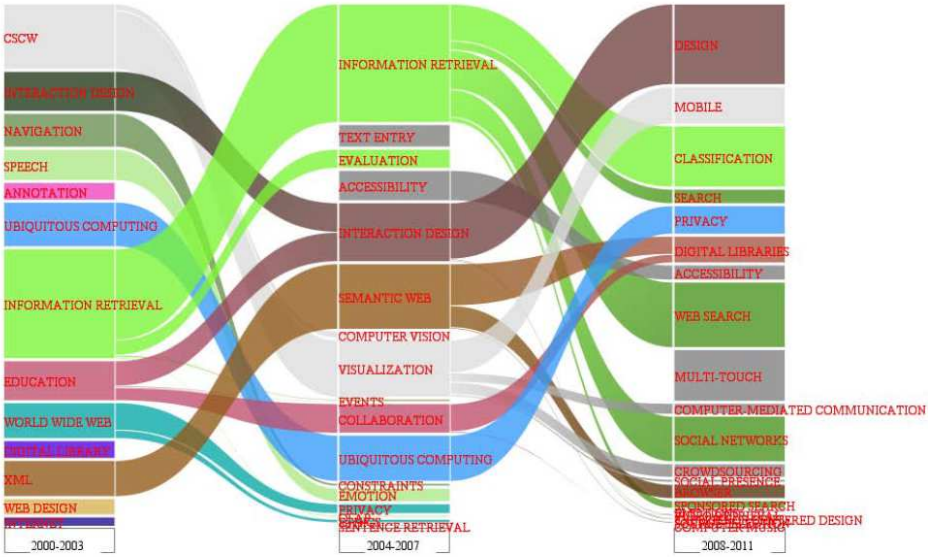


Figure 5. The overall topic evolution on FIVE-CONF dataset

Figure 16: Example of an alluvial diagram; source: Gorraiz et al. 2013a, 1315

Geographic map-based diagrams like cartograms are similar to the mappings described above, but clearly allocate data on top of geographic maps to connect data to geographic regions. Figure 17 shows a map of Africa with single countries marked with different colouring and figures added aside.

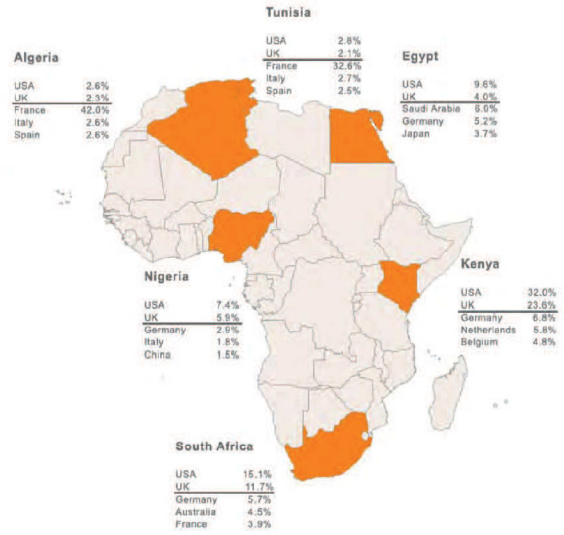


Figure 3 Most frequent intercontinental research collaborations for six key African research economies

Figure 17: Example of a cartogram; source: Gorraiz et al. 2013b, 322

Network visualisations were used very extensively in the context of bibliometrics and there are several different visualisation tools in use. For a multifaceted analysis of network visualisations and their production, see Mayer 2011 (Mayer 2011a).

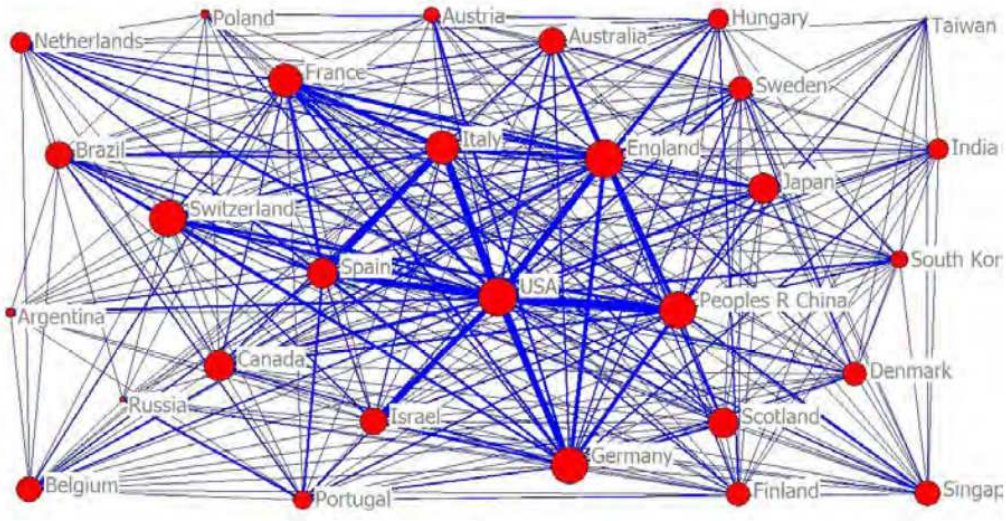


Figure 7. The international collaboration network of complex networks

Figure 18: Example of a network visualisation (1); source: Gorraiz et al. 2013b, 838

Figure 18 shows a network shaped arrangement of monochrome lines and circles while Figure 19 works with coloured circles and lines (VOSviewer). In the case of the the latter, the remark in the labelling, saying “full view” suggests that the network diagram originally interactive and that the presented visualisation is not a fixed object, but only one still of and endless range of possible perspectives at the network at stake.

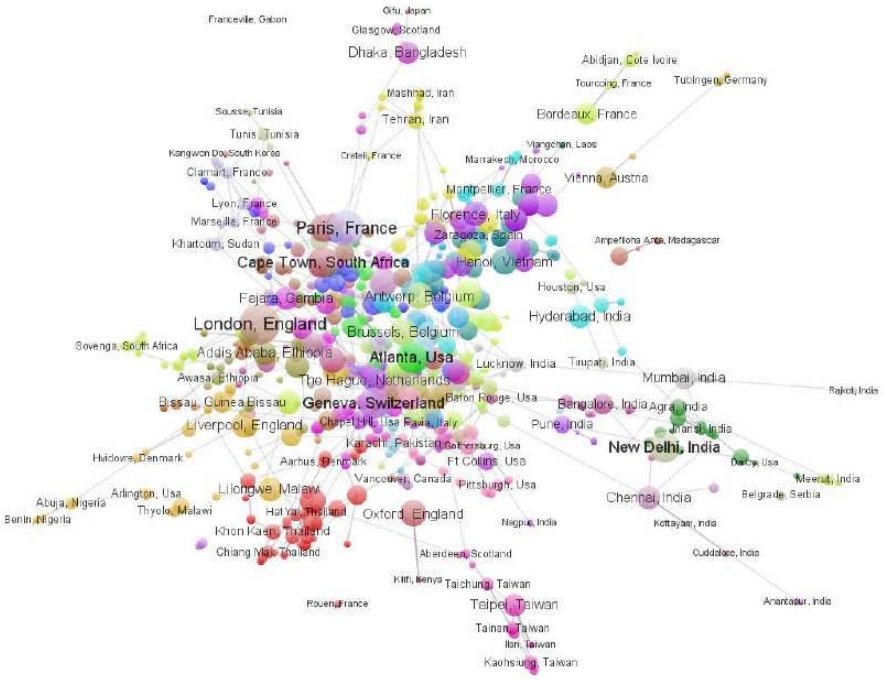


Figure 12. Collaboration network for tuberculosis (full view, 2002–2006)

Figure 19: Example of a network visualisation (2); source: Gorraiz et al. 2013a, 1413

Assuming that many of the visualisation outputs were ‘photographs’ from the computer screen they were produced from, there were also screen shots that were obviously intended to show events of a computer screen themselves. Figure 20 and Figure 21 both show examples of this case, the first one being in Chinese with only the label in the conference language (English) and the second one showing a user interface and one exemplary visualisation output. Depicting software interfaces was rather done by the presenters that were at the same time (co-)developers of the software itself.

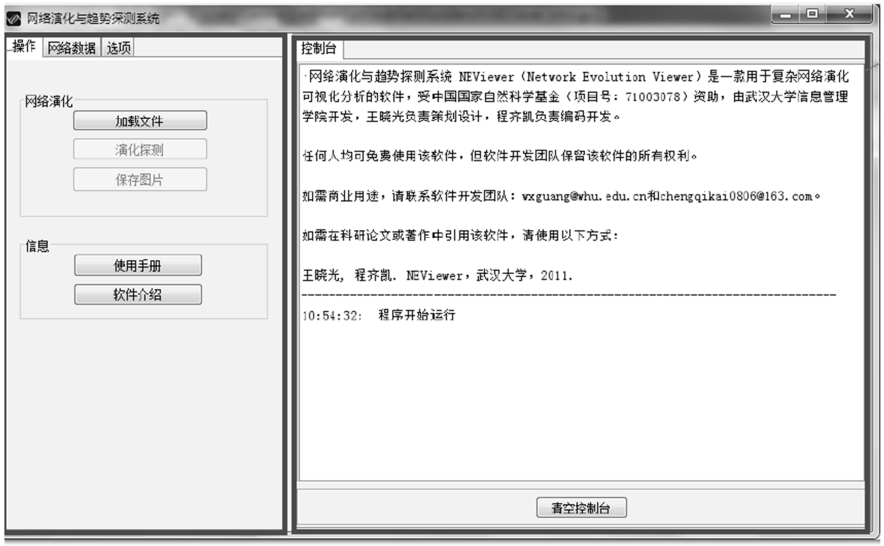


Figure 4. Main view of NEViewer

Figure 20: Example of a screen shot of a software interface for visualisation (Chinese); source: Gorraiz et al. 2013a, 1313

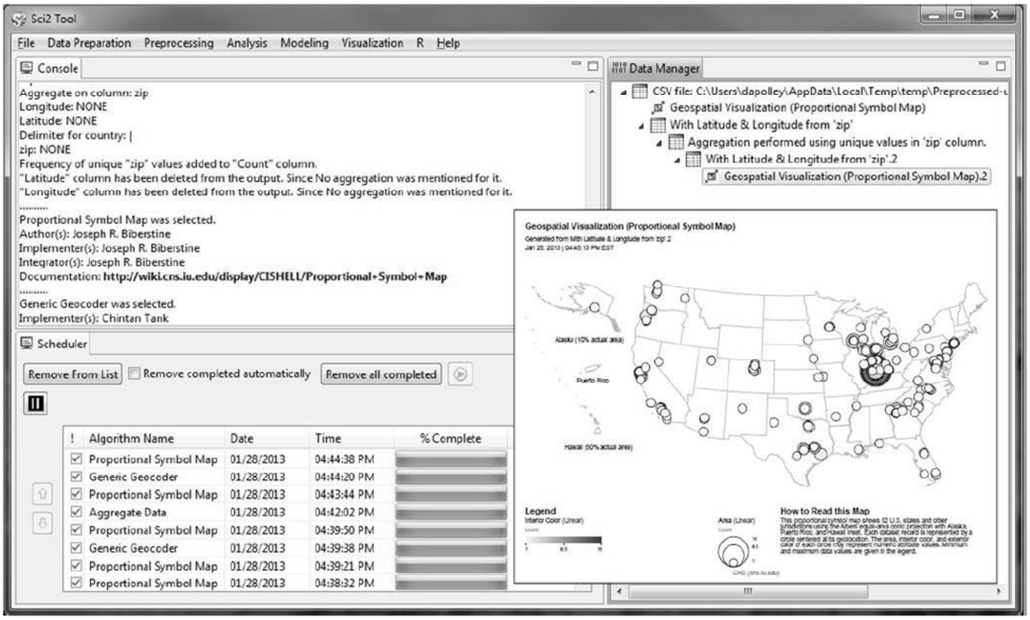


Figure 1: Sci2 tool user interface with proportional symbol map visualization.

Figure 21: Example of a screen shot of a software interface for visualisation (English); source: Gorraiz et al. 2013a, 1346

Especially in the poster sessions drawings, illustrations and cartoons were deployed – see chapter 5.3.3 in Figure 28, Figure 29 and Figure 31.

4.2. Research Field, Data and Methods of Data Collection

The following section reflects upon the methodological framework to reveal the factors that formed the choices for and features of each method but also delivers arguments why other common methods were not applied in this context. Further the principles for field work are stated, as well as the specificities of the field itself are described.

4.2.1. Literature Review

This section is a statement of how the literature review plays a methodological role, rather than comprising the review itself. The actual literature overview can be found in chapter 2 *Visualisations in Scientometrics*. As a method, the present review serves in identifying relevant pieces of literature to base upon the argument of this research idea in and position it into the concerned discourses. It also drafts an overview of recent discussions in bibliometrics and scientometrics itself. Eventually a closer look at the concepts in use are given by contextualising them within basic STS reading and to explain in what way they are operationalised to understand the ethnographic field.

Feeding into the discourse of the performativity of scientific images, the concepts of image production, engagement and deployment are contextualised for the scientometrics, bibliometrics and informetrics community. Specificities of the social construction and production of scientific knowledge in the disciplines dealing with quantitative measurement of scientific output are briefly discussed and assessed with regard to the explicit or implicit target audience(s) and traditions or patterns.

The ways in which the literature and plenitude of scientific texts related to the question was navigated through was certainly shaped by the way science and technology studies was taught in the context of the Masters programme of STS in Vienna, more specifically oriented to the texts and authors that were read in the different seminars, which built the base of the understanding of STS concepts and ways to ask questions. Building on that, strategies of advancing and broadening the body of literature were inspired by those that were applied in the author's first thesis, a trained pragmatism as well as snowball-techniques that lead from one piece of literature to an ever increasing amount of new pieces referenced. Furthermore, the central journals of the field of scientometrics ("*Scientometrics,* Springer") and STS ("*Social Studies of Science*" and "*Science, Technology and Human Values"* both Sage journals) gave a rough orientation of the major discourses in each fields. Consequently and

in line with Hart, it has to be acknowledged that "[a]*ll reviews, irrespective of the topic, are written from a particular perspective or standpoint of the reviewer.*" (Hart 1998, 25).

4.2.2. Analysis of the Conference Papers

About two weeks before the start of the ISSI conference 2013 the proceedings of the handed-in papers including all papers and posters involved were published online with a heavy-weighing quantity of more than two thousand pages to scan through.

For a first overview and ironically totally in line with the whole idea of the thesis project a simple *wordle*[7] tag cloud visualisation was created by analysing the full text of the proceedings, counting the frequency of appearance of words. The size of the word on the visualisation represents the amount of times counted – the bigger it is illustrated the more often it is used in the texts of the conference proceedings. The version of the picture is after the removal of common English expressions[8] (automatically) and manual removal of "neutral" worads within this very special context[9].

Figure 22: Wordle[10] with the 250 most frequent words within the ISSI 2013 conference proceedings

Approaching the field with a first visualisation gave a slight idea of important terminology in the field, a sense of what geographic regions could be of importance ("China", "American" and "USA" are mentioned) as well as names of central authors. It also gives first impressions on *visuality*, although the term "visualisation" itself is not amongst the 250 most used

[7] www.wordle.net
[8] e.g.: and, of, to, etc.
[9] without: research, scientometrics, informetrics, bibliometrics, conference, per, et.al., de, e.g., however, i.e., among, within, main, many, may, also
[10] Made with a word-count-based tag-cloud visualisation tool at www.wordle.net

expressions (e.g.: “characteristics”, “networks”, “shown”, “patterns”,…). Also, “Technology” seems to play an important role.

Albeit the size of the proceedings documents there was yet no further need for complex analytical strategies to process these documents. The content analysis consisted of three steps: 1) key word search – in the sense of a thorough scan of the conference papers for significant terms (such as *visualisation, image/ing, picture,…*) and for the contexts they are used in, 2) a scan for the visualisations, illustrations, images and graphs published in these papers and 3) a distinction of the different forms of visualisations leading to a choice intended to including rather wider variety of forms than comparing similar ones.

From this first impression of the variety of visualisation topics covered in the turn of the analysed event, panels participant observation were chosen and anticipations developed on what kind of discourses on the visualisations of scientific output might be covered. As conference panels often happen in parallel, another range of choices had to be made considering the researcher’s own possibility to attend and gain most possible insights e.g.: by picking those panels that have several presentations of interest rather than only one. In Figure 23 the different panels of all three conference days are listed. Each cross indicates a paper that was identified to fit into the present analysis according to the three steps as described in the previous paragraph; panels that were planned to be visited in advance are marked light grey. The choice of what panels were chosen to be visited took two factors into account: 1) the quantity of papers of interest and – in case of equal quantities 2) explicit contents of the papers. The second factor was accounted for only in one case: on the panel at 15:30 to 17:00 on Thursday, July 18. Here panel A was visited because of a presentation by members of a visualisation team that had already held visualisation workshops in the forefront of the days with panel sessions on Monday, July 15. Since it was not possible to access this workshop, by sacrificing panel C in favour of panel A, it was hoped to join in discussions that might have already started in the course of these previous workshops. Panels in the morning of July 18 could not be visited due external factors.

Panels	Hörsaal 23	Hörsaal 28	Hösaal 16	Elise-Richter
Tuesday, July 16	A	B	C	D
11:00-12:30			x	xx
14:30-16:00	x		x	xx
16:30-18:00				x
Wednesday, July 17	A	B	C	D
11:00-12:30	x	xxx	x	x
14:30-16:00		x	xxxx	
16:30-18:00		xxx	x	
Thursday, July 18	A	B	C	D
11:00-12:30	x		x	
13:30-15:00				
15:30-17:00	x	x	x	x

Figure 23: Matrix of the ISSI programme and the number of presentations that were rated as objects of analysis in the course of the content analysis of conference papers; source: screen shot of own table

Any decisions taken in this step of analysis had certain impact to the present research and fed back into the literature review as the focus was laid on comparable work that has been conducted within these anticipated discourses or on production, engagement or deployment of similar visual concepts in other disciplines. Also, there might have been “losses” of interesting cases of visualisations that were presented in “non-visitable” panels. The sum of 17 presentations that had been identified as appropriate and “visitable” was certainly not a *representative* sample in a statistical sense of the word, but nevertheless it was a sample that offered a broad as possible diversity of the objects in observation within the context of the events visited.

4.2.3. Ethnography

Not only the visualisations that are the interest of the present study, but also this ethnography itself is a representation of some *real* and therefore is inherently partial – in the sense of on the one hand only being able to describe and treat a certain small part of the world out there, on the other hand always being biased and political and in a third sense, shaping and *enacting* the real while describing it (cf. Winthereik and Verran 2011, 48; Law 2009).

Ethnographies have been deployed quite commonly in Science and Technologies Studies and there is rich experience that can be drawn into. Apart from Beaulieu’s reflections on co-presence in fieldwork (Beaulieu 2010, 2) and technical aid provided by Creswell (Creswell 2013) a closer look was taken on several previous ethnographies relevant to this work (e.g.: Latour 1996; Downey and Dumit 1997; Law 2009; Burri 2008b; Knorr-Cetina 1983)

In order to be able to understand the scientific community of scientometrics at the ISSI conference in Vienna and to outline an ethnography from the findings made, participant observation as a method was assessed as being appropriate for this purpose.

For the approach of ethnography used in this study, reflections are taken into account that were made around critical ethnography (cf. Madison 2011). Behind the background that visualisations in scientometrics are very likely to be fed into policy recommendation logic, a scientific field with strong political connections is analysed. In parallel, conducting an ethnography is a political task in itself, since any publisher of research is always acting politically in the sense that certain ideas and ideals about society and power relations are incorporated that eventually shape the way ethnography is conducted which in the case of this study may have consequences on how the scientometric community and their pictures are being *represented* in this work. Orienting on Madison four of the five questions suggested were posed self-reflexively on the conducting researcher's role in the ethnographic process: 1) *How do we reflect upon and evaluate own purpose, intentions and frames of analysis as researchers?* 2) *How do we predict consequences or evaluate our own potential to harm*? 3) *How do we create and maintain a dialogue of collaboration in our research projects between ourselves and Others?* 4) *How is the specificity of the local story relevant to the broader meanings and operations of the human condition?* (Madison 2011, 4).

In the context of the present research it should be reflected on what kind of generalisations can be drawn from the set of scientists in this ethnographic study to the scientometrics research community in general or the way images are used in other contexts and where generalisations are critical or inacceptable.

Hess observes retrospectively that in STS there were two generations of ethnographic traditions and that the newer one exceeds the idea that it is to open the black box of knowledge production, but to analyse the various boxes that might or might not play roles and how. He postulates that *good* ethnographies *"reveal competence, interpret complexity, interrogate the taken-for-granted, and make an explicit empirical or theoretical contribution to a literature"* (Hess 2001, 9). Even *better* ones, as he puts it, should then contain reflections of how these boxes might be constructed better and propose alternatives. Therefore that kind of ethnographies are taking their own political stance, while the "better" and its criteria have to be made explicit and their contestability acknowledged.

4.2.4. Participant Observation

All the panels chosen were visited; some from the beginning to the end, while others were switched at some point when there was an interesting parallel sessions. This was decided and adapted dynamically according to the conference circumstances and own capabilities of processing new sessions. Participating in various presentations comparison of the performativity of the images presented and discussed. As expected, it also happened that one new presentation which had not been identified during the content analysis of

conference papers was afterwards taken up and in two cases the presenters did not hold their presentations.

While participating in the panels and discussions field notes were taken, slide shows copied where the presenter was willing to share a digital copy and occasionally pictures of the images used were taken. Following Emerson et al. who stated on the one hand that "[f]*ieldnotes are distinctively a method for capturing and preserving the insights and understandings stimulated by these close and long-term experiences."* (Emerson, Fretz, and Shaw 1995, chap. one), it was on the other hand also acknowledged that "[g]*iven the reductionism of any method of inscription, choice of method reflects researchers' deeper assumptions about social life and how to understand it. Fieldwork and ultimately the fieldnote are predicated on a view of social life as continuously created through people's efforts to find and confer meaning on their own and others' actions."* (ibid.; see also Emerson, Fretz, and Shaw 2007).

The material gathered was merged with the field notes taken during the observations and fed into a field report of each panel visited, summarizing the most noteworthy elements of observations to draw conclusion on.

4.2.5. Qualitative ethnographic Interviews

On occasion, short semi-structured and open-ended ethnographic interviews with participants, the presenters or other individuals involved (for example the organisers) were eventually conducted (Kvale and Brinkmann 2006a, 110). The conversations were partly structured by pre-developed questions, but they also left space open for the interviewee to develop their own reasoning on the given topic of the interview, if time allowed it. The underlying approach was a constructivist one, assuming that both interviewer and interviewee are collaboratively co-producing the interview conduct (Kvale and Brinkmann 2006a, 128 f.). Also in the two poster-sessions between the panels researchers presenting their printed graphics observations and conversations with the creators and presenters took places to understand their view of their visualisations printed. Additionally an interview with two of the conference organisers was conducted in the preparation phase before the conference, both members of the bibliometrics team at the library of the University of Vienna.

4.3. Methods Used in Data Analysis - Data Validation and Interpretation

The empirical data gathered was documented, structured, validated and analysed in constructivist manner (cf. Akrich 1992; Morus 2001) by first of all listing and sorting the conducted interactions within the field. Additional and continuing documentation of the data was necessary because all notes were handwritten or as audio recordings. This was done purposefully, as it forces one to deal with the whole richness of data once again and serves as an important work step for inspiring new ways of organising, sorting and understanding the events that happened in the context of the research question.

Based on the different digitalised field report scripts of all the presentations extraction of recurring elements and their contextualisation were undertaken. Coding central key concepts, discussions and notions that either came up during the conference participation or during documentation of the gathered material enabled one to observe where similarities or contradictions in the performativity of image use were (cf. e.g.: Ball and Smith 1992). These notions or “codes” served as an orientation for the ideas that structured the results section and fed interpretation categories. These steps of analysis were applied by fellow researchers before (cf. Williamson 2006, 88). As planned there were no technical aids used to code and analyse the data material (apart from the standard search function in text processing tools), rather qualitative methods dominated here as well:

4.3.1. Analysis of Field Notes

To enable comparison between the different presentations and visualisations under observation, a framework of analysis for ethnographic field research was developed and structured along six aspects of investigation:

A. Kind of Visualisation: A description of the type, styles, and the reasoning for the choice of this way of imaging
B. Target group(s) and Audience(s): the implicit or explicit target group for the way of visualising data was noted or assumed. This may differ from the audience in the conference setting but does not necessarily have to.
C. Spatial issues and setting: The room as a physical space and the conference as a virtual social space was considered and their role in the composition of performativity analysed
D. Discussion of the Visualisation: the negotiation of what is made visible and how it can or should be read by the audience was tracked. The discussion can be led by the presenter(s) and/or in interaction with the audience and might follow-up within the

interviews before or after the specific session. Discussion analysis includes at minimum 7 different elements:

1. Content, data – and its role
2. Inscription of Meaning
3. Aesthetics, Design, Arrangement
4. Actors
5. Epistemic Standards
6. Metaphors and Stories
7. Technical Issues, Production

E. Relation of Data/Knowledge/Text and Presentation/Speech: the gap between *what* is presented and *how* it is presented were observed.
F. Construction of *imageability*: What are the claims that the specific elements need visualisations and how is it negotiated to reach a common sense in "envisioning" the underlying meanings?
G. Performativity: The image as an actant.

These dimensions were structured and printed as a guideline for the participant observation and "filled-out" in each of the visited session, one for each presentation under analysis.

For making sense of the collected and filled sheets they were then compared according to the above dimensions and contextualised to feed the three leading question aspects in this study as outlined in chapter 3. Further analysis of the different field report sheets was conducted by on the one hand comparing their inherent similarities and differences and on the other comparing their negotiation and performance work.

4.3.2. Analysis of Ethnographic Interviews

Following analysis strategies as suggested in Kvale and Brinkmann 2009b, 189 ff. there were no fully-fledged extensive interview transcripts made. Most of the interviews conducted were recorded, depending on the situational requirements and possibilities. In some cases the conversation took place in a corridor with plenty of physical and acoustic disturbances in other cases there was no time to switch on the recorder or it probably assessed as not desired by the speakers recorded (e.g.: in discussions). Therefore the conducted interviews were on the one hand analysed by an "*immanent analysis-in-situ*" (Kvale and Brinkmann 2006b, 191), meaning that there were on-site decisions made on what is important being further analysed and what is not, and notes were taken accordingly. For those interviews that were possible to be recorded, transcripts of the passages of assessed interest were made to be able to set direct quotes, following the same principle: only elements considered relevant

for further analysis within the context of the research question were transcribed and made citable.

As any interview is *co-authored* by the interviewer and the interviewee the notion of "collecting data" through interviews is not appropriate as conceptualised in the context of this work. "*The Interview is an inter-subjective enterprise of two persons talking about common themes of interest* […] *and the interviewer's active listening and following up on the answers co-determines the course of the conversation*" (Kvale and Brinkmann 2006b, 192). Consequently this way of understanding interview conduct leads to an acceptance that interpretation work is already done during the interview itself and can vary according to the social situation, the personalities of the interview partners or even their conditions at that very moment. According to a hermeneutical and postmodern way of interpretation the interviews analysed naturally "*allow for a legitimate plurality of interpretations"* but it is necessary to "*explicitly formulate the evidence and arguments that enter into an interpretation*" and acknowledge "*perspectual subjectivity"* (Kvale and Brinkmann 2006c, 212, 213).

4.3.3. Coding, Developing Concepts,

For analysing the sum of the two data strands recurring issues were clustered and coded and taken as categories for further analysis and interpretation (cf. Hammersley and Atkinson 2010, 158 ff.). The fusion of the collected data interpretations is available in the later chapters, resulting in an overall conclusion in the last one.

4.4. Critical Reflections on Field Research and its Limitations

For this chapter I reserved all questions I posed myself during the field research in order to provide some space to discuss these issues. Partly it was tricky for me a researcher, trying to understand processes in scientific knowledge production from a more qualitative perspective, to observe those colleagues that try to do the same with quantitative methods. It is even more delicate to do that since I am embodying both of these kinds of researchers in different social contexts (work, studies) and eventually I am one of my own research objects since I am visualising data myself.

First of all I want to clarify here that I had concerns including the first person "I" and talking about myself within the present and the introductory chapter, while trying to avoid it in all the other chapters, which may seem to be an inconsistency. Concluding, that neither form (the "I" or "the author") guarantees better objectivity it was decided to basically stick to dis-personalised (or generalised) or passive formulations as this is what appears to be more common while in passages with clear, inevitable and beneficial reference to my person, the individualised form was accepted as an exception. Inside the two chapters where this

exception was made, the respective form for expressing personal views or experiences was used consistently.

During the analysis work I recognised, that I implicitly tended to take the observed cases as *typical* for the *community* and from the few examples of conference presentations emerged something like a *prototype* of a scientometrician making and discussing visualisations. Knowing that this picture in mind was a fusion of very likely not representative set of presentations in a statistical sense it seemed dangerous to concluding in statements of the kind "*this is what they do"*. It was attempted to put it in a way to a more "*this is what was observed as being done and these are the ways that seem accepted in the specific setting of this conference"*, yet the prototype image in mind was not easy to be ignored.

In the sense of Beaulieu's *co-presence* which describes possibilities to extend ethnographic investigations from *co-location*, being the actual presence on a certain location, to a broader variety of modes of meeting and participating or *going into the field*. This for example happened via information and communication technologies (Beaulieu 2010, 2) and by "artificially extending" the conference situation by keeping contact with the scientists and screen the videos taken during the conference. By creating the *field as an object* I try to cultivate the whole range from preparations, over presentations and discussions at the conference itself to the aftermath discussions and further reflections to understand the way scientometric knowledge is enacted, perceived and discussed visually.

At some point I realised that more pictures should have been taken. As it was intended to analyse the performativity of the visualisations, photographs appeared too static for my needs. But as it happened that the actual work of the examination of results took place months after the actual events, more visual means of documentation would have probably been helpful. Fortunately the organisers of the conference provided comprehensive photo coverage of the event and shared the material[11].

The observations made here and the analytical results neither allow inductive reasoning on images in scientometrics or any other social sphere in science in general nor give a complete picture on the scientometrics community and its practices. They only enable to describe and understand possible mechanisms of explaining and negotiating scientific images through ascribing them certain agency and performativity. The observations made in this specific case might or might not appear elsewhere. Furthermore depicting the images under observation makes me part of the dynamics I am trying to describe and therefore I am co-producing the enacted realities I am claiming to find. By citing John Law saying "*Our own*

[11] Photographs publicly available for download here:
https://www.dropbox.com/sh/qclzt0oe93vzfd6/WacehV9ib6

practices enact collateral realities like any others. We are no different." (Law 2009, 15) I want to acknowledge that although I tried to understand how my own practices re-enact realities, it will never be possible to escape from *doing* it.

Also theory-wise the present approach is a very partial one since it almost entirely ignores discussion strands in anthropology, culture studies, *visual culture* providing image theory, arts theory like aesthetics and arts history as its theoretical foundations. In this work images are analysed in a certain point in time and in a certain social space and are treated as performative objects or actants *as a whole*, rather than opened in their production, aesthetical features and components - a definition which is admittedly hardly possible to be delimited. Following these objects in its development and transitions between different spheres, but also deconstructing these images or analysing their production process are surely interesting topics to be discussed elsewhere.

5. In the Field: ISSI 2013

The following chapters present a description of the fieldwork experience and the way and the kind of data gathered during the time of Monday, July 15 to Friday, July 19 2013 during and around the ISSI conference which took place at the historic main building of the University of Vienna, Austria.

5.1. Description of the Study Environment

The International Society of Scientometrics and Informetrics (ISSI) was founded in 1993 but conferences on bibliometrics, scientometrics and informetrics had already been organised biannually since 1987 – most of them in Europe (Belgium, Germany, Sweden, Spain and this year Austria), two in North America (Canada and USA), two in South America (Brazil and Mexico), two in Asia (India and China), one in Australia, another in South Africa and one in Israel[12]. This broad range seems to underline the notion "international" in the association's name and also in the heterogeneity of the participants at this year's conference confirms the international orientation of the conference.

The ISSI conference is the oldest in bibliometrics or scientometrics. Another important one is the Science & Technology Indicators (STI)[13] conference organised annually since this year

[12] http://www.issi-society.info/past.html
[13] E.g.: 2014 conference in Leiden, Netherlands: http://sti2014.cwts.nl/Home

for similar target groups (in 2013 it took place in Berlin). COLLNET[14] additionally deals with science and technology collaboration and there is an increasing number of national symposia "popping up" (e.g.: library sciences Regensburg). Other gatherings that were mentioned by during the interview at the university library in preparation of the conference itself were the QQML[15] and the European Summer School on Scientometrics (ESSS)[16]. The former is a conference on quantitative measures in library science, which they considered questionable content-wise. On the contrary, they strongly contributed to the latter in the same year. [Int-1, July 11]

Vienna was chosen by the ISSI committee as a venue for the ISSI conference 2013 from several cities applying. The interviewees at the university library supposed that this was because the 2008 STI conference was organised by the University of Vienna through which it gained a good reputation as a conference host and as a result it was chosen to organise the 2013 event. The rooms at the main building of the University of Vienna were booked naturally because the university provided a 50% discount on the room rents. [Int-1, July 11]

As main strands of discourse in the discipline, the organisers identified several issues. First of all they felt the need of demonstrating that bibliometrics is more than citation analysis, which alone is considered as not very meaningful, especially in social sciences and humanities. *Altmetrics* are therefore a growing topic in the field, dealing with alternative measures experimenting with the consultation of data from social networks, social bookmarking tools and developing complementary impact measurements. Another issue was the improvement and meaningful combination of existing indicators, which in the opinion of the conference organisers should be more sophisticated than only using means and percentiles. Besides reference analysis, also data visualisation was mentioned, since a great amount of tools has been developed in recent years. [Int-1, July 11]

The ISSI Conference 2013 was well attended – even the organisers were surprised by the high registration numbers and eventually more than 350 visitors from more than 42 countries took part in the conference. More than 40 participants were from Germany – or to be more precise: had an affiliation with a German institution. The second biggest group of participants were Chinese, followed by researchers from Spain. Only in the fourth place were Austrians (excluding the conference organisers) and afterwards North American scientists, which is remarkable because the community of Scientometrics seems to have its historical roots in the United States of America and many of the most central personalities are actually North-

[14] Global Interdisciplinary Research Network for the Study of all Aspects of Collaboration in Science and in Technology; http://www.collnet.de/
[15] International Conference on Qualitative and Quantitative Methods in Libraries; http://www.isast.org/
[16] http://www.scientometrics-school.eu/

American (considering for example the origin of the *Derek John de Solla Price* awardees[17] and the impact measures of individuals of their own community).

The core part of this fieldwork took place after the first day, which was dedicated for a doctoral forum and several tutorials and workshops, most of them dealing with analysing and visualising bibliometric data. As registration for these hands-on sessions was restricted, only one tutorial that was organised together with the author's colleagues from the Centre for Social Innovation could be attended. As it was purposefully desisted of including auto-ethnographical elements to this study and due to the focus on the performativity of scientific visualisations rather than their production, no field notes were taken during this session. However, it was an interesting entrance point for this field study since members of the visualisation community as well as several other participants from various cultural and disciplinary backgrounds were presenet, enabling a first impression of what the conference *culture* was going to be all about.

Each of the days that followed (Tuesday, July 17 – Thursday, July 18) started with a plenary session and continued with a series of parallel sessions, including poster sessions on Tuesday and Wednesday right after lunch break. In sum, it was possible to observe more than 20 presentations in 8 different sessions, in which 17 of the presented papers were of relevance within the context of the present research project and it was these 17 where field notes were taken. The way these sessions were chosen is described in the following section.

5.2. Preparations: Content Analysis and Choices Made

For choosing the "right" panels to visit a series of decisions was made according to the following prerequisites for a panel:

1. certain types of visualisations have to be presented, aspiring for a maximum overall variety
2. the presentations could not take place at the same time
3. expected performativity of the visualisations

To cover the first prerequisite and to approximate image use within the presentations, the images presented in the published conference proceedings in advance were analysed. For this purpose, more than two thousand pages were scanned for key terms like "vis(z)ualisation/-ing, image/-ing", etc and for the printed visualisations themselves. A list of potential sessions for participation was created based on this. Panels with the highest number of suitable presentations ranked higher than those where only one presentation was

[17] http://www.issi-society.info/price.html

relevant in the context of this study. Sessions on Thursday morning could not be visited due to other (external) commitments. The resulting reduced list of analysable presentations was then prepared in terms of pre-screening of the respective papers, feeding the meta-data into the headers of the orientation sheets for the field work (see methodological chapter 4.2.4) and printing them out. Unexpected drop-outs of presentations were anticipated (and happened in two cases) so empty forms were prepared in order to spontaneously add a different presentation, which happened in one case. During the observation no distinction of the in- or exclusion to analysis was made – it was decided that all field reports would feed into the study. Content analysis data and reading of the conference proceedings afterwards interacted with analysis as sometimes understanding of contents of the papers was necessary to understand their visualisations' performativity.

As a noteworthy side note, it could be mentioned that it was fascinating to observe the usage of images in the closing ceremony of the ISSI conference. As it seems, there is a strong culture of communicating less scientific elements and messages visually: two videos built the conclusion of the gathering, one promoting Istanbul as the next conference venue and another one staging some of the impressions of the conference in Vienna, cut in a few scenes. One of the convenors even stated that it was almost a tradition of AIT and the University of Vienna to close their conferences with audio-visual impressions of the past days. With access to the video material provided by the organisers at the University Library of the University of Vienna, it was retrospectively possible to enhance some parts with using this sources of information for analysis.

5.3. On-Site Experience

5.3.1. Participant Observation Data

It was possible take field notes in 17 presentations in various sessions between July 16 and 19 in 2013. It was decided to treat all presenters of the 17 sessions anonymously at first sight. Table 1 below lists dates (day of the month in July 2013), numbers the sessions in chronological order and indicates the country of origin of the presenter based on the affiliation indicated in the conference paper as well as the gender of the presenter. This information was intended to give the researcher orientation during analysis and maybe also the reader. From this table it can easily be observed that this is a international and rather male dominated field. Obviously, the table easily allows reconstruction of who these individuals are by comparing with the conference programme.

#	Date	Country	Gender
1	16	USA	m
2	16	UK	m

3	16	USA	m
4	16	BE	m
5	16	SE	m
6	16	CN	m
7	17	CN	m
8	17	JP	f
9	17	CN	m
10	17	BE	m
11	17	USA	m
12	17	NL	m
13	17	CN	m
14	17	USA	m
15	17	RU	m
16	18	NL	m
17	18	USA	f

Table 1: List of visited presentations that are basis for ethnographic analysis

The actual presentations were very heterogeneous in terms of the disciplinary backgrounds of the presenters, style and visualisations chosen and the way they were reflected. There were similarities, though:

1. the structure of the presentations were quite comparable: an introduction of the project, methods chosen, data retrieved, how data was analysed, results and discussion. The visualisations were typically part of the analysis or the results sections.
2. The audience did not question or reflect the type and features of the visualisations in the discussions that followed the presentation except for those questions that were raised intentionally in context of this study. Some presenters did talk about their considerations towards their images, but most of them did not.

For further analysis each presentation was coded numerically by their chronological occurrence. As evident in Table 1, most of the participant observations took place on Wednesday, July 17, whereas most of the interviews were held on Thursday, July 18 (see Table 2 in the next sub-chapter). During each presentation the compilation of field notes took place as follows: The types of visualisations were tracked and notes were taken on the go, as ideas and thoughts emerged. In “thought breaks” – when the presenter was talking about things that were not so relevant for the observation or after the presentation – the grid as it was suggested in the field observation guidelines (as described in chapter 4.3.1) was filled out according to the outlined dimensions.

While screening the different slides, the presenters had different strategies of explaining the intended story line behind the slide show. Almost all the papers analysed were co-published by several authors or probably the more stable term of “research groups” can be used here. The presentations were exclusively conducted by only one of the authors, who was not always the first author mentioned in the submitted paper. Some used microphones, some did

not. Some walked while talking and pointed with their hands and fingers towards the wall screening the projection of their slides, others used laser pointers, and few preferred to stay seated behind the computer screen. In some sessions the echo in the seminar room was an issue, other session sufferaed from the lack of fresh air and the heat on those hot summer days in July.

Figure 24 shows the setting of *Hörsaal 28* from the audience's perspective. The spatial arrangement suggests rather low interactivity between speaker and listeners and so does the temporal setup of the conference: each presentations was supposed to take 20 minutes including question and answers, so time for bringing across the most important elements of research and allowing profound discussion was scarce.

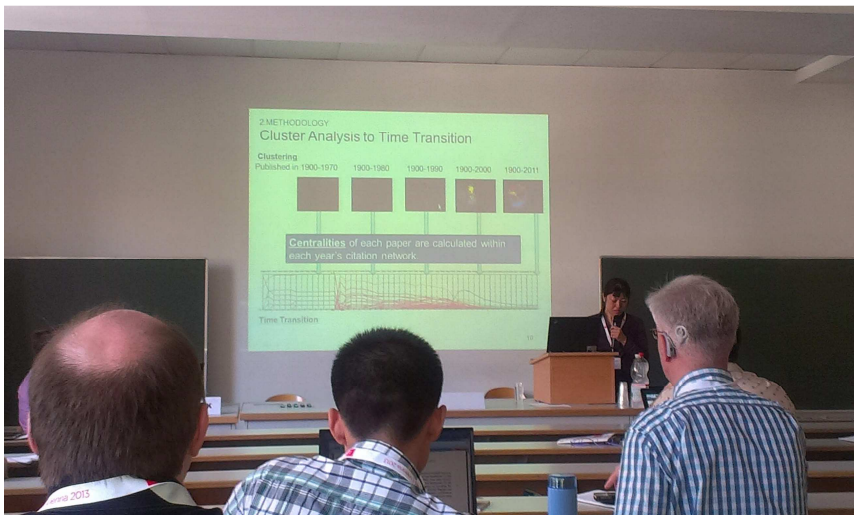


Figure 24: Setting of a paper presentation at ISSI'13; source: photo taken by the author

5.3.2. Qualitative Data from Interviews

It was possible to conduct nine ethnographic interviews; five of them were also audio-recorded. For a couple of them interview questions were prepared, some interviews had fixed appointments with regard to time and interview location while others were less formal interviews and conversations with only written notes. Presenters, other conference participants and the conference organisers served as interview partners. None of the interviews was fully transcribed, but passages were picked out and indexed for further analysis. Notes from non-recorded interviews were translated to English where necessary and turned into indirect citations.

The questions and structure for each interview emerged in the progress of the conference. First, potential interview partners were identified and chosen, judging from their performance or their perceived role within the scientometrics community and of course depending on their availability and willingness to be interviewed. In a second step a series of questions and

topics were developed in advance for the conversation with each specific person, but were adapted dynamically during the course of the interview. The results and experience of one interview had impact on the way the following interviews were conducted and what questions were asked and how. Sometimes previous interviews made further interviews obsolete or changed the scope of the questions that seemed useful to be asked.

Table 2 below lists and consecutively numbers these conversations and interviews in chronological order and discloses the day each of them took place and the way they were documented manually or digitally, including the length of the audio-recording taken. The description of the interview partners derives from their self-presentations retrievable online and role they seemed to play at the conference. The labelling of nationality and gender is not intended to be a classification of interviewees in a statistical sense, but to provide a vague idea of what kind of talks took place – resulting in the anticipatable *picture* of mainly *Western* and *male* actors who were dominantly present. This is only partly true, as introduced in chapter 5.1 and might also be derived from the author's own cultural imprint given the fact that no strategic attempts towards a representative sampling were made. The codes in the first column are introduced for uniquely assigning directly or indirectly cited statements within this study to each of the interviews. Where recordings were made, time stamps are added to the interview references, indicating the minutes and seconds of the moment the cited utterance was made.

Code	Date	Interviewee(s)	Type of documentation
Int-1	July 11	Organisers, scientometricians, Spanish and Austrian, male	notes
Int-2	July 16	Analyst, scientometrician, British, male	recorded (24 min)+ notes
Int-9	July 16	Social scientist, Belgian, female	notes
Int-3	July 17	Analyst, scientometrician, Canadian, male	recorded (21 min)+ notes
Int-4	July 18	Computer scientist, scientometrician, Dutch, male	recorded (21 min)+ notes
Int-5	July 18	Software engineer, Chinese, male	notes
Int-6	July 18	Participant, physicist, Australian, female	notes
Int-7	July 18	Scientometrician and STS researcher, Dutch, male	recorded (16 min)+ notes
Int-8	July 19	electrical engineer, computer and information scientist, German, female	recorded (35 min)+ notes

Table 2: Overview of the interviews conducted and type of documentation

In sum, there were almost two hours of interviews recorded and about 20 pages of field notes derived from conducting ethnographic interviews. For processing this data it was decided beforehand that no full transcripts would be made but rather interview field reports summing up and explaining the field notes, enriching the data with original statements citing selectively from the interview recordings. The longest interview conducted was the last one and this was possible, because it took place in the conference's aftermath which made it possible to go into detail on questions.

5.3.3. Poster Sessions

On the first two regular conference days a one hour time slot after lunch break was reserved for coffee break and poster presentations. The position of the poster walls where the products were pinned on was in the four-sided central arcade courtyard of the prestigious main building at the University of Vienna, where one side was reserved for the buffet and coffee supply and a second, adjacent side of the court yard was dedicated for the poster presentations. This spatial setting made the poster sessions easily accessible. As a result the poster session was well visited by the conference attendees, there was quite a crush and many of the posters were discussed between the audience and presentersa. Where none of the authors was present, people did not stop by as frequently, even less so when there were no images or visualisations. During discussions the posters were utilised as boards by their presenters to point at elements of interest while explaining their insights, as visible in Figure 25:

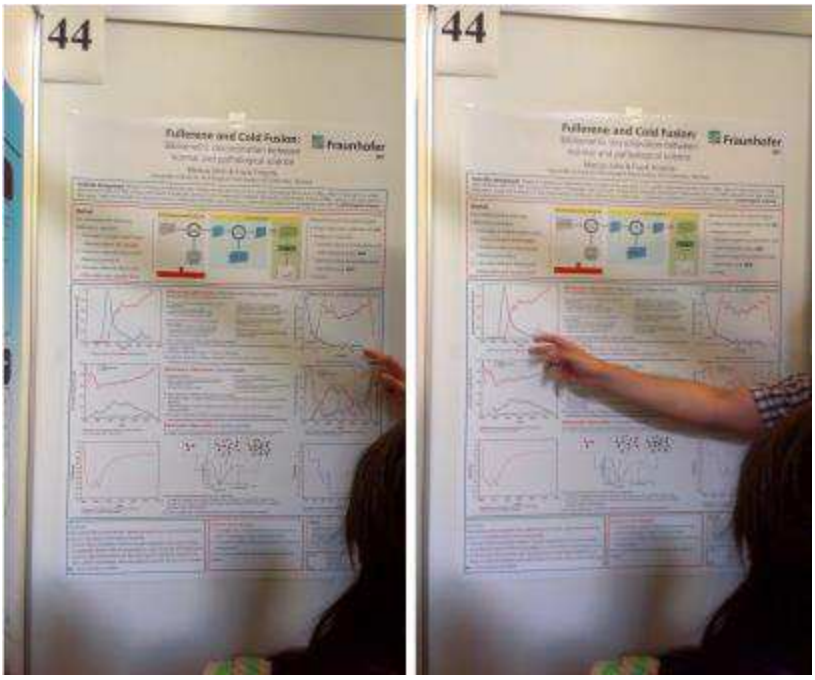


Figure 25: Presenter at one of the *Poster Sessions* explaining graphs and results; source: photos taken by the author

Some appealing effect of the visualisations and images to visitors could be observed, as well as the presenters' clear utilisation of their pictures to transport the key findings by *showing* and being able to *point at* results as seen in Figure 25.

The variety of posters ranged from rather textually focussed exemplars (cf. Figure 26), to more graphically elaborated posters with focus on design elements supporting the intended communication process. These design features were reached from different strategies of organising the information graphically on the provided space, over the visualisation of data

results in diagrams, graphs, maps, etc. (cf. Figure 27) to decorative elements and even cartoon images (cf. Figure 28).

Figure 26: Poster with plain text and tables; source: photo taken by the author

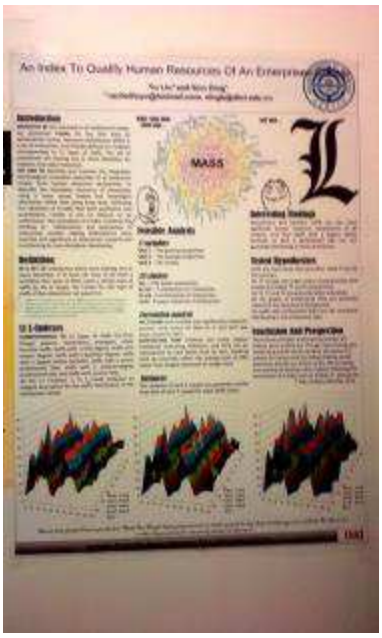


Figure 27: Poster with different types of visualisations and graphical elements; source: photo taken by the author

Figure 28: Poster using cartoons for explaining contents; source: photo taken by the author

As a service for visitors, some of the posters had printed hand-out versions on standard sized paper to be distributed to the interested audience. This strategy resulted in pro-longing the communication process to the time after the poster sessions or even after the conference and therefore *enlarging* the given space effectively. Yet at the same time it could be observed that posters with hand-outs were not consulted as exhaustively, presumably because the audience felt they should spend more time on those posters that “could not be taken home with them”.

Following this trend and also observed during the panel sessions before and after the poster sessions, there were also several examples of including geographic maps with overlays of visual elements (colours, arrows, etc.) to communicate data (see Figure 30).

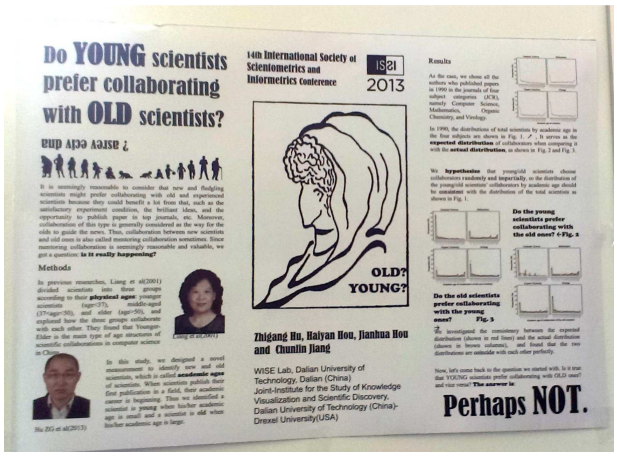


Figure 29: Poster using typographical elements to emphasise the argument; source: photo taken by the author

Other posters playfully arranged typographic elements to emphasise their main argument, like realised on the poster shown in Figure 29 that also includes a very well-known optical illusion by W.E. Hill.

Figure 30: Poster using maps of Europe for visualising data; source: photo taken by the author

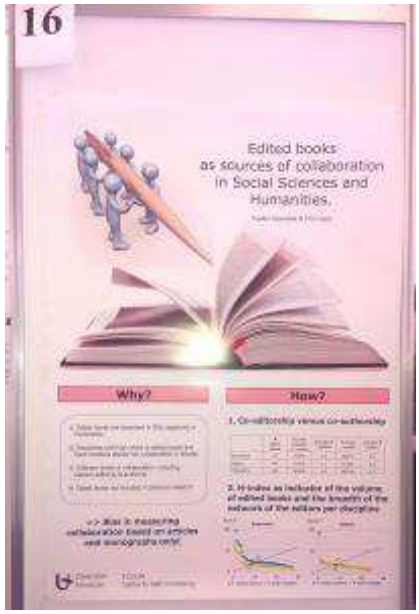


Figure 31: Example of a poster with illustrations and graphs; source: photo taken by the author

One of the poster presenters was addressed with the question of the expected effect of communication by the graphical style and elements used. The presented poster was one of two exemplars designed in landscape format and had information organised in fields along parallel time lines (visible in Figure 32).

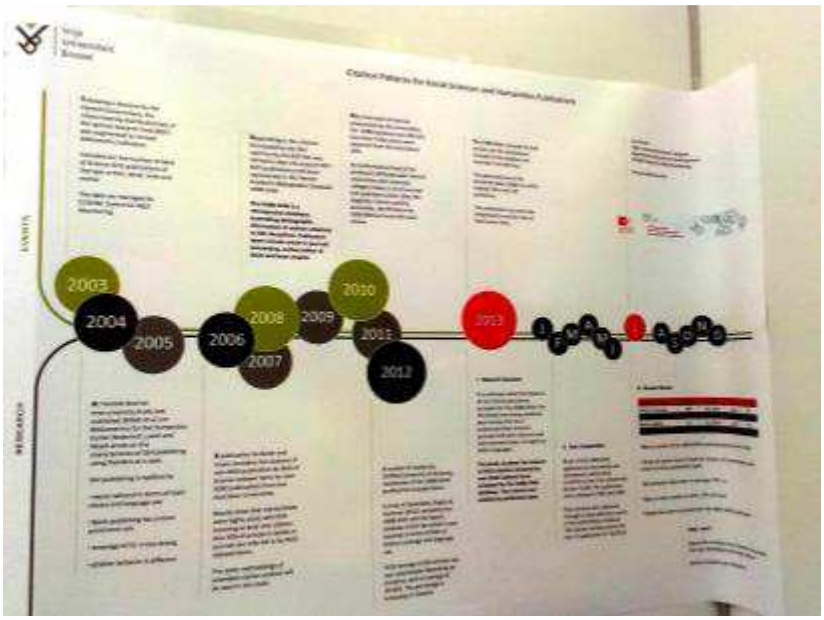


Figure 32: Example of a poster designed in landscape format; source: photo taken by the author

Arranging data along a graphical logic reminds one of the techniques used in media for designing *infographics* that are intended to transport 'digestible chunks' of information in a visually pleasing or appealing form. Remarkably the conference logo was positioned on the poster, marking it as inherently part of the conference perhaps to manifest its own importance or 'right to exist' in the context of the event or maybe even the community as a whole.

During a conversation with the author, a question on the visual and content-related impact of her work emerged, especially in context of the neighbouring poster, visible in Figure 31. She stated that it was difficult for her to find a balance between presenting just enough text to get her research results across and at the same time have it arranged according to aesthetic features. According to her observations, fer colleague right beside her poster spot attracted more attention with the iconic illustration of a book as an eye-catcher. Yet she added that she *"had some few interested people who really discussed contents"*. She also reflected on the meaning of the *Best Poster Award* which was granted by the conference organisers allegedly based on votes by the conference participants. The presenter was wondering, how the variety of very different posters could possibly be compared and in what factors – "*by scientific content? By beauty and design? Or by the originality of the presented ideas?*" [Int-9. July 16]

The *Best Poster* which was awarded on the last conference day, was not photographically documented in the course of this study, which suggests that it did not contain forms of visualisations (other than graphs) that attracted the author's attraction, so probably design elements were not awarded a high priority. The poster awarded was created by authors that

are rather active and renowned members of the scientometrics community, which is remarkable in itself.

5.4. Aftermath: Filling Gaps in Data?

Actually the risk of not being able to gather enough or 'usable' field data was over-estimated in the preparation phase of this study. Enough data and information was compiled and in principle need for further investigations or ex post data retrieval was not assessed as necessary. Nevertheless it was decided to collect material gathered by the conference organisers for example photos and the video recordings of plenary sessions or panels, which could be not attended.

Two presenters whose presentations had been identified in advance as having relevant visualisations were not able to take part in the conference and therefore their slots were filled otherwise. It was also considered to contact them in the event's aftermath, but given the rich data gathered, it was decided against.

In general full focus could be laid on the analysis, interpretation and summarising of the field data as it was, yet acknowledging that any results of the ethnography designed here could only deliver an arbitrary snapshot of the whole *picture* that is by no means representative.

6. Results and Discussion

The following sections elaborate on the empirical findings and weave them into the logic of analysis according to the three aspects described in chapter 3.

6.1. Interpreting Empirical Data

Inevitably, *interpretation* of the empirical observation has already taken place – not only by the choices made before field work started with respect to framing and selecting the field and its elements, but also by the inherent choice of the relevant observations and field notes to be processed in the present study. Weaving the different parts together tells a narrative that would probably not have been told in this way if a different person would have done the study. The way this work is organised it is intended to allot a plain observation report in chapter 5 and its sub-sections, but inherently it is not and can never be, since any description is partial. There is nothing like an objective overview of what happened, so it seemed arbitrary to even try it. The above sections undoubtedly already contain judgements about what the observations may *mean* in the context of the scientometrics discipline and how they

are important to the argument. In the following section, as a next step, the attempt is made to weave the different strands revealed in the previous parts into a different discussion containing aspects crystallised out from the literature as well as the observations to eventually have the potential to sum up the key issues found and feed into the conclusions and outlook in chapter 7.

6.2. Visualisation Culture and Techniques

Understanding the first aspect of the research question is to assume the observed visualisations as technology that is socially shaped. This chapter also describes different observations of the field in order to provide an overview for the following analysis sections. At first we have a look at how choices of image types and technologies and choices of ways of showing matter and shape results. As Bastide states, the automatic production of images can be seen as an "excuse". *Everybody* is using them, although it is clear that they are specifically shaping the way we "see" things: "*it allows a specialist to grasp the "facts" at a glance instead of relying on the intervention of sophisticated decoding equipment. We have seen, moreover, that though the reality that appears there is constructed, it takes on a role of a guarantee because of its automatic production."* (Bastide 1990, 213). Considering the fact that most of the visualisation tools are widely used, as they are derived from common office software (see Figure 5 to Figure 8 and their description in chapter 4.1), it is observable that they play the *role of a guarantee* as described by Bastide.

As outlined in 4.1, very different visualisation types found their way into the present study. From a technical point of view it seems worth mentioning that some of the visualisations are made with the help of the same office software the slide show presentations are made with, that seem to be standard in bibliometricians' working environment. The other types of visualisations are often derived from visualisation tools that are open source and free of charge and therefore also easily available. The fact that the visualisation tools are free of charge gives the impression that the creators of these tools view themselves as being in service of supporting the discipline with suitable, easily applicable tools and provokes the assumption that the software engineers try to specialise and tailor their programmes to fit to the bibliometricians' needs. This is especially remarkable against the background that the sources of the data under examination is in most cases from one of two major scientific citation databases (*Elsevier's Scopus* and *Thomson Reuters' Web of Science*) which are proprietary and owned by renowned companies (in the Netherlands and the USA respectively). These companies were also represented by their own stands at the ISSI'13 conference. Having the power to shape and control the data that is being analysed, these database suppliers play a specific role in the scientometrics community. There are plenty of

endeavours to include more and different sources for analysing scientific output, like open access databases, Google Scholar and social media platforms like *Mendeley* or *ResearchGate*. Consequently the relation between the software engineers and the database companies and bibliometric data is an interesting one for bibliometrics and its visualisations. It might be the case that prevailing ideas of dynamics and networks in today's science are nourished and co-produced by this relation in a similar extent as they are developed by the discipline of bibliometrics and scientometrics. The situation becomes more entangled, when the database providers have their own analysts and visualisation specialists employed.

Apart from one keyword speech[18] that made it into the present choice of observed presentations, none of the visualisations used seemed to have been applied for mere "entertainment", although, as will be seen in in Figure 33, there were some used for decoration purposes e.g.: on the title slides. The presence and availability of visualisation software as well as digital image processing plays a crucial role in the usage of images in the field. This was also deduced from several interviews: *"A lot of people use the software, because the software is there. So there is a big tendency in the field to produce nice drawings."* [Int-3, July 17, 00:55-01:07]. Developments in computer technology in the last decades were mentioned as driver for this tendency: *"Everything has changed in the direction of visualisation. Windows was in 96' or so, since Windows 98' you had graphic interfaces. Before that we did not have graphic interfaces. Nowadays everything has become visual. The human eye is very able to recognise patterns and data in pictures. Even before we find the articulation…"* [Int-7, July 18, 14:00-14:39].

The visualisations and graphs in this analysis were embedded into the slide shows e.g.: as part of the results but were also used as design elements. Figure 33 on the left hand side shows the title slide of an exemplary presentation which already anticipated the visualisations that would later be used as part of the presentation in a colourful header. The right hand element of this figure depicts a later slide with similar images as part of the study and embedded in a diagram and a legend underneath.

[18] This very keynote speech was full of insightful visualisations, but the fact that most of them were applied for certain entertainment and show-effect was reason to exclude this episode of the ISSI conference from the main parts of the present analysis. Yet this interesting turn to "pop culture" in the context of general modes and styles of presentations at international scientific conferences and this was outspokenly appreciated by the conference organisers.

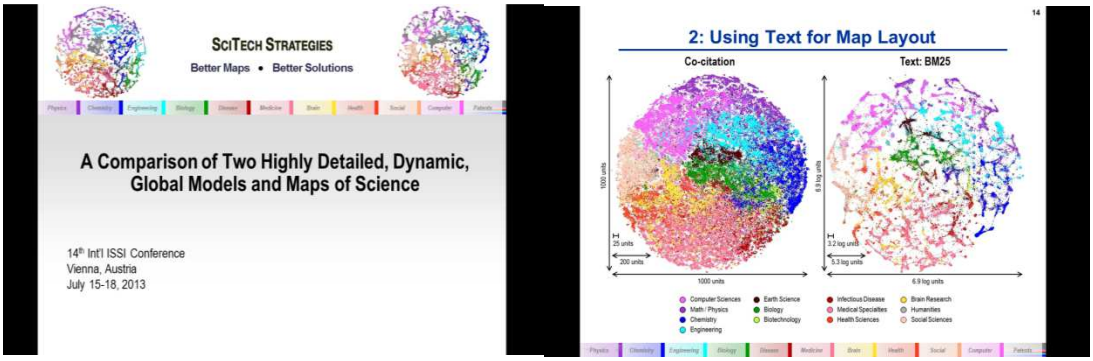


Figure 33: Two slides of an example Power Point presentation. Screen shots of the original slide show after removing the authors' names; source: slide screen shots of a presentation provided by one author

Most of the visualisations were presented to speak on their own with only a short title. Others attached information on data source(s) and data range, name of the visualisation tool and parameter values chosen, variations in view and perspective, legends and some already hinted to interpretation possibilities. Figure 34 is an example of a visualisation with a label that suggests ways of reading it.

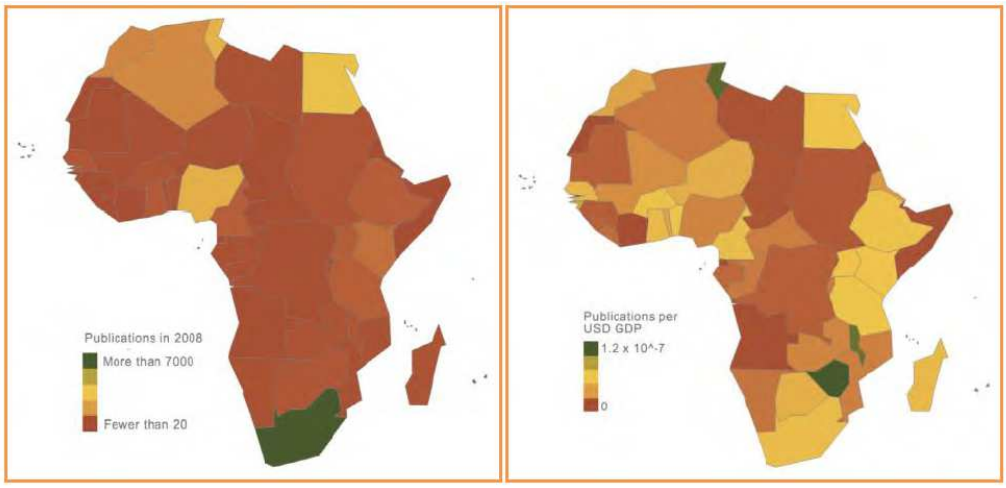


Figure 2. Output per country in 2008 as total volume (Figure 2a) and as volume/GDP (Figure 2b). South Africa is absolutely the most productive country. Zimbabwe appears to be relatively productive but this is an anomaly due to very low recent GDP and a strong historical base. Tunisia is relatively the more productive on current performance.

Figure 34: Visualisation example with a comparably detailed description in the caption; source: Gorraiz et al. 2013b, 320

Many abbreviations remain unexplained and seem to be commonly known, standard in the community or represent something not needed in understanding the visualisation itself (for example the name of the visualisation tool). New tools and the more visual way things are processed and communicated are regarded as serving cognitive and perception processes better. Serving these processes even *better* was the underlying thought when interviewee 4, a computer scientist, said the following: *"In this field there was already a tradition of making maps of science* […] *At that time we had a careful look at all the techniques that were used*

and at that time we thought, well there is a lot of room for improvement" [Int-4, July 18, 02:45-03:50]

Both, the computer scientists as well as the scientometricians came up with claims about *accuracy* of their visualisations – a notion that was quantified and even calculated and measured in some of the cases. Increasing accuracy was a stated goal suggesting the underlying positivist premise that there must be some real picture of science and it is the scientometricians' goal to find it and visualise it as accurate as possible.

Aesthetics were an issue, as the following remark by one of the presenters shows: *"some of you will probably laugh at me because of the colour scheme"* while his successor countered afterwards *"I am ashamed of showing this map after yours"* and *"…these visualisations are old and only taken from the appendix of our study"*. The later statement raises a range of questions on what is considered as "state-of-the-art" visualisation and whether this notion is connected to style or complexity in the sense of dimensions (data-relations) being visualised. He excused himself for not being a computer scientist which seems to be a prerequisite to produce *meaningful* or *beautiful* pictures. His study group used their type of visualisation for supporting a decision within the study for one of three models. This kind of "decision help" was unique as compared to the other ways visualisations were instrumentalised in the observed studies.

The negotiation processes between the different strands in computer science about distinct types of visualisation and standards, as well as another thought about their own position constructed as a service provider to the community of scientometricians is observable in the next three statements: *"At this moment I think I have a position in the field, especially in visualisations. I address a lot of technical issues – technical limitations, problems – and I try to solve them. And I hope with feedback from users, how they use the maps, what questions they try to answer, will make contributions and improve the techniques more and more."* [Int-4, July 18, 04:19-05:00]. Framing his conference fellows as "users" places the scientometrician into a different role than a scientist trying to produce knowledge (visually). He understands the dialogue between technicians and users as progressing, towards a common consensus of standards to be used: "*If I look at the techniques: we have a lot of discussion with the technical people that are behind all those techniques and I really see that we are going to a consensus. Also on the type of data that is needed to construct those maps. There are a lot of different types of data that can be used* […] *and now they are all convinced that this is the way to go."* [Int-4, July 18, 07:06-09:01].

A user-programmer relation was deepened in another description: "*We have all kind of techniques to quantify the quality of maps, but in the end the users have to use them, so the*

judgement of the users is really important. […] In the end, the users want to see a picture that they generally also have in their own minds. If it is totally different, the user thinks the map is not right." [Int-4, July 18, 14:44-15:35]. Clearly leaning towards a positivist approach to data analysis, be it with statistical or visual methods, the following utterance can be mentioned: "*Our task is to make the best reliable visualisations that provide correct information.*" [Int-4, July 18, 12:16-12:29]. Others considered it more important to keep the tools they are using as simple as possible in order to keep what is happening to their data "under control", although the visual results may not be as appealing. In their opinion it was more important to have the visualisation tool as broadly accessible and utilisable as possible, rather than the aesthetical features of the visualisation product itself. In their words it was considered important, that the tools they are using are not "*too black-box*", in the sense of obscuring what is being done to the data. [Int-1, July 11].

In another statement it is revealed, that having the code accessible and therefore being able to retrace exactly how a visualisation is made, is not always an asset. Researchers or analysts are prepared to take the loss of these insights in favour of having a software tool that is regularly maintained and updated and therefore provides some warranty to work reliably: *"…in our business we are using… 70 per cent of the value-added comes from commercial software, 10 per cent from open source and 20 per cent from internally developed… we are scripting a lot [...] there is a bit of programming involved and there is a bit of open source software, but not that much […] but commercial software for us is bread and butter. We don't*[19] *have time to be embarking on codes – we want something that works.*" [Int-3, July 17, 16:10-18:00].

The analysts interviewed admitted having copied their images from their commercial studies and re-used them in scientific context: *"Most of the time when I'm coming to a conference, it's a spin-off of some work that I've done for some clients, so I just pull out* […] *I wouldn't necessarily say that what I present here is very different from what I have been presenting to my customers* […] *Yeah, I put more details here and I feel I can be a bit more "geeky", but I don't consider my clients children* […] *they are frequently scientists but otherwise they are intelligent adults and that's what I always consider even when I come to a conference, because people are peers here, they are not necessarily working in the same field* […] *assuming that they are intelligent adults trained in a university, that's my baseline."* [Int-3, July 17, 13:52-15:01]. In the second part of this citation we find an assumption about the audience and environment the visualisations are to perform in. Explicitly mentioning the performative aspect of images, interviewee 7 ascribed certain agency to visual elements, he

[19] Contractions were decided to be kept in direct citations just the way they were outspoken in the oral interviews. Colloquialisms like "gotta be" were exchanged for more formal phrases (e.g.: "has to be").

would preferably name *illustrations* of what was found in the data: "*Maybe sometimes you are a bit overpowered by the performativity of the visualisations. I think visualisations are not so strongly analytical; you need the statistics behind it. They are a very convincing way of showing things, of illustrating things. Illustrating is the better way. And then they add a lot of value, because if you present a table or bar charts people find it much more difficult to read if you are able to visualise it. And we have now these nice programmes freely available, so let's use them!* " [Int-7, July 18, 01:49-02:38]

The notion that visualisations of information are reduced to *illustrations* was also observable when the same interviewee talked about the power of visualisation tools to understand complex and big amounts of data – a role that he allows these tools to have, although he favours the final product to remain an illustration: "*The visualisation itself provides you with a means to scan large data or complex data, which is sometimes very difficult to oversee* […] *I am not pleading for using visualisations instead of doing serious research. Visualisation is also a domain in itself.* [Int-7, July 18, 15:04-15:35]

Many of the interview partners described visualising their data as a tightrope walk between *transparency* in terms of methods and data used, and *simplicity* in terms of reducing complexity to provide a comprehensive picture of the claim to be made. Also aesthetics play a role that is regarded as overruling usability and which is not so recommendable in some cases: *"I tend to use graphs more than tables when I do presentations, because I think it's way easier* […] *and a lot of people just can't read a table… and it's boring to read a table."* [Int-3, July 17, 12:31-12:48]. The same person proceeded with saying that *"for me they need to be both: scientifically sound and also robust from a communication point of view"* [Int-3, July 17, 06:00-06:10]. Certain scepticism about using images was also mentioned: *"Initially we were a bit reluctant to use them* […] *For me you have to prove that something is useful to be adopted; so I adopted it for two reasons: 1) there is a "wow-factor and I am running a company, so I need to sell my work and people look at these images and they say "wow". Okay, so a part of it, to be honest, is that. Other people do it so to some extent you have to do it.* […] *Our main use of visualisations is quite simple and oriented to decision makers. They have no time so I need strong analytical instruments that can convey a message quickly… I think there is an abuse of visualisation in this field. There are too many nice images being presented with no or very shallow analysis of what's going on. And images are sometimes the best tool and sometimes they are really useless at describing a situation. And I think they are being used regardless of their capacity to help us and help our 'clients'."* [Int-3, July 17, 02:04-04:10]. As an explanation of what a meaningful visualisation would be, he stated: *"I tend to say, if you can't easily write a paragraph about an image, then don't present it! It means that you can't make sense out of it"* [Int-3, July 17, 04:53-05:04].

The above four citations from the same interview lets one assume that the interviewee reflected before embedding visualisations to his work. His statement on *scientifically soundness and robustness* was relativised afterwards with a side-remark stating that he would trade a bit of scientific soundness to get the message across properly, given that "*by and large it is correct"* [Int-3]. This notion was discussed by other presenters that in turn asked for more theoretical guidelines, for instance on colouring schemes: "*Sometimes for example the colouring of the visualisations should be based on analytical considerations – for example factor analysis. Theoretically guided. Ideally we should have theoretical guidance*." [Int-7, July 18, 02:40-02:57].

As the conference organisers put it in their interview, the main issues with using visualisations in their field is that in some cases colleagues use images that are "*just not meaningful and not necessary, maybe even dangerous.*" The high speed and ephemerality of our times as well as the nature of bibliometrics being "*at service*" of politics and the short decision times, demand for good graphics that are comprehensive. "*One picture says more than a thousand words*", they agreed and stated that sometimes the graphics produced are just *pleasant* to gain a quick overview of what is at stake. According to them using a table would often be better, depending on the situation and the context but especially in front of scientific audience. The considered institution cleaning, descriptors, field normalisation and author-identification as the major (technical) problems for scientometric visualisations at the moment. [Int-1, July 11]

One study group presented their visualisations if they were pitching to potential customers with their products being tools that would be useful (from an engineer's logic). The different options or visualisation styles derived from the application of *different algorithms* – a procedure which was used equivalently in different *ways of analysis*. Consequently the algorithm is what conducts analysis or what one sees is a choice of mathematical treatment of our data. The scientist is able to make the choice, but it is the algorithm that is the bottleneck for *visualisability*. Therefore algorithms increase possibility of understanding the data at hand since the computational effort can be remarkable high when big data amounts are being processed. In the sense argued in this certain presentation, the algorithm is also the bottleneck of what can be made visible and therefore *perceivable.*

From an outsider's perspective, the first female interview partner concluded that she partly came to the conference to compare her own work as physicist for a university library to the research presented at the conference. She was hoping to gain inspiration from the visualisations of other groups in the community. However, she admitted that she had not learnt a lot but her personal approach was reinforced. She was not sure "*where to go with*"

several very complex network analyses. She stated that the more complex an image is, the less likely it is to be understood and the less likely transparency towards the data and the modes of production is to be kept. In her opinion there should be a purpose for any visualisation, they should be simple, "transparent" and meaningful at the same time, whereas in the contrary many images are used just because they are *beautiful*. For *really complex* relations she rather recommends textual descriptions; otherwise she feared that things would get even more *obscure*. Ultimately she considers the integrity of the underlying data as the real issue. [Int-6, July 18]

Issues of complexity were also stated in another interview: "*A visualisation is always a two-dimensional projection of a complex* set […] *you are still making a reduction of the complexity. In principle you are working in "nD" – in a large dimension's domain. Traditionally we used multi-dimensional scaling* […] *which also allows you to do visualisations* […] *You could also do an nDs for three dimensions* […]*, so you could look at the data from different perspectives. That's very useful. One of the ideas I have is that in the future we should have perhaps synchronous visualisations of patents and publications on split screens. That would be very nice. That allows you to have different perspectives, particularly in innovation studies that would be very useful, to be able to move from one domain or another."* [Int-7, July 18, 05:35-07:04].

Why, how and what should be visualised is influenced by several factors, including the prevalence and usability of visualisation tools or expected effects of the images. Therefore, often the construction of imageability is rather pragmatically driven. Those who had actually reflected upon what is reasonable to be visualised and in what context had several arguments why their images are valid for interpretation. One group had an approach that combined qualitative data from an ethnographic study and enriched their representations of quantitative data with the qualitative results. Another group explicitly stated that their images were derived from a study report to decision makers; therefore they were inherently designed to make an argument and to transport it efficiently. *"Visualisations deeply inform people"* was their explanation for choosing this form of representing their data.

A different group attracted attention by the way they concluded their results that were mainly visual: *"England is very much in centre of Malaria Research"*. The hierarchical notion of centre and periphery in science networks is said to originate from the imperialist line of thought (Schott 1993) and has been around even before scientometricians produced complex diagrams of social networks. However, the way this statement was made, made it seem obvious that the accorded visual claim cannot be made without that type of visualisation. The presentation that followed reacted to the content of their predecessors'

study in an interesting way: *"It feels the conference setting is too big for our small study*), somehow positioning themselves to an imaginative periphery of the representatives of a scientific discipline presumably present, not specifying in more detail whether the sample size, the methods applied or maybe even the self-judged appeal or elaborateness of visualisations led to this conclusion.

Again a fascinating argument for imageability was made by another researcher who said he wanted "*describe our research*" with visual representations. This maybe was not intended to be taken literally by deconstructing it into the Latin roots that would mean that his research was first *written* (represented textually) to be now visually "dis-written" or *de-scribed*. But yet this deconstruction opens an interesting aspect in understanding the role of the visualised data. In the literal sense it would mean, that textual representations are again decoded and relieved from their textuality ("de-scribe"). In the sense of Akrich, the de-scription of an object would mean that readers or spectators of, in this case scientometric visualisations, are re-opening what was manifested to be an object. The previous process in which the visualisation was created, had been *in-scribing* certain meanings, moral values, ideas about what should be presente, etc. (Akrich 1992). Consequently, the cited presenter of visualisations must have previously *inscribed* meaning to his objects, in order to enable his visual results to be *de-scribed*. He himself therefore has *de-scribed* his own data to become images. This means that the researchers themselves try to deduce their own data with images, which was also stated by some interviewees "*There need to be exploratory tools which you can use to make sense of your data"* [Int-8, July 19, 05:19-5:25].

A different presentation by a computer science specialist or software engineer focussed more on the visualisation power of algorithms that their research group had developed and technical details of how it works. In their logic, visualisations are there to *"make something really readable"* (which is again a reference to textuality). Their image showed data material from over 10 years which was a big amount of information in this context and accordingly, their visualisation was crammed with details. The presenter's comment on the full-data form of the representation was that it was "*too big for printing"*, which opens up several questions on imageability and form. While what we may expect from a *traditional* way of producing comprehendible scientific output would be an approach that leads scientists to the choice of their visualisation types or the forms of representation from the format they have to deliver. Dealing with big data amounts as well as scalability of visualisations when shown on a screen demand and enable kinds of visualisation that may eventually exceed standard printing limitations. The use of images therefore changes.

From this case study there were two general contradicting tendencies observed: the belief that the more complex data sets are, the more complex their visualisations need to be, while the others in contrary share the opinion that the more complex an issue is, the more simple visualisations have to be in order to be able to speak for themselves which after all should be the ultimate goal. In both cases visualisations are handled as the key towards understanding data. Imageability implicitly is constructed with remarks like *"with this visualisation we are tracing relationships"* and *"this is what we see"*, suggesting that the representation is an aid for analytical means.

Scientometricians' use of visualisation is not only determined by obvious technological decisions (reducing complexity, understanding big amounts of data), but also more social factors. Availability of the software tools supports their usage which is additionally shaped by the active role of their developers in the "scene". The specific constitution of the community of actors with different backgrounds and aims affects the use of visualisations and makes their sources broad in variety (e.g.: scientific papers, analyst reports, university statistics…). Presenters also partly define their own role within the community by the quality or aesthetics of their visualisations.

6.3. Mediators Between Disciplines

The second aspect deals with how visualisations become boundary objects between different disciplines. As boundary objects, the visualisations in observation at the ISSI conference had a lot of work to bridge communication between various social spheres and disciplinary borders. "*Scientists and other actors contributing to science translate, negotiate, debate, triangulate and simplify in order to work together"* (Star and Griesemer 1989, 388 f.), in all tasks that boundary objects are created to fulfil. The visualisations in this case were for example instrumentalised to create allies for the own research argument in the presentations given. They were instrumentalised to underline an argument, especially when studies were used in decision making contexts. Many of the visualisations were derived from reports, meaning that the main envisioned audiences were initially policy makers and science managers. While on the one hand the analysts presenting this kind of visualisations usually act as consultants, they interact at conferences as scientists. Others present scientific results, but also take advantage of such gatherings to promote the visualisation process or software behind it (by computer scientists and engineers). In other cases, visualisations were deployed for appealing effects and to manifest professionality within the field. Given the different application fields, visualisations have to become transportable.

"*I think visualisations can really help to bridge between experts and a general audience, but they can also help to bridge disciplinary boundaries.*" [Int-8, July 19, 7:10-7:20]. This

statement by the last interviewee opens a discussion on multiple layers. It raises questions on how disciplinary boundaries are enacted and surpassed, what environments and contexts visualisations do perform in and it introduces a certain duality between those who know and those who have to be educated on a deficit-model construction of a general audience, a notion that is also enacted in her next statement. The same researcher positioned herself as an electrical engineer, but acknowledged that her disciplinary way of thinking and the audience she was addressing at the conference differed: "*I am an engineer; I would like to build things that are actually useful. And that's very different from many others at the conference, who have other goals."* [Int-8, July 19, 12:21-12:30].

A consideration going into a similar direction was also pronounced by interviewee number 7: "*You primarily work for an argument and then illustrate it, isn't it? … but I am not sure if all my colleagues here are working for an argument… we come from different disciplinary background – as a social scientist you are"* [Int-7, July 18, 07:35-08:02]. Researchers were not only using the images for underlining their argument, setting them into a position of a mediator towards their audiences, or even only as a means in itself. In contrary, the above mentioned *usefulness* was defined differently by the computer scientist as something that increases once understood by a public and as broad as possible audience.

Computer scientists seem to play a comparably new role in the field since visualisation and data processing tools have become increasingly important in recent years. Already established members of the discipline have uttered sceptical thoughts about this fact: "*Computer scientists are always a bit… how do I say that politely… they very much have a tendency to set the agenda. So you hear them making references to what is common in other fields and they mean their standards. But I don't think that it's so important to us. We have difficult problems by ourselves, because eventually we don't want to map information, we want to map knowledge. And that's not the same thing. The knowledge is often the latent dimension of the information. How the information is being organised and why it is being organised* […] *Modern knowledge is consulted discursively in communication and then information is also transferred. We have the information, the traces of this transfer and we can map that. It's not sufficient. We have to map meaning and knowledge. We have a long way to go. But it's a different way from computer science, which wants big data, more data, computer power, more standards… so we are on a different track. Hopefully we can keep our track. Library and information science on one side and STS on the other side."* [Int-7, July 18, 08:36-10:21]

This observation was cemented by Interview 8, when a computer scientist said that more standards have to be defined and there is need to learn how to deal with big amounts of

data. Talking to two more computer scientists, the counter perspective was further elaborated: *"Our task is to make the best reliable visualisations that provide correct information."* [Int-4, July 18, 12:16-12:29]. The other computer scientist interviewed stressed that visualisation tools can only support solving visualisation problems once communication measures move more towards computer science logics. As it is possible to visualise any imaginable network, not just collaboration networks, he considered his work not specifically be part of the community he presented his work to, but useful in many different fields. He announced that his tool will be able to visualise a third dimension soon, which he considered useful to the present community. [Int-5, July 18]

According to these statements, visualisations are an entrance point for computer scientists into the field of scientometrics (besides technologies for dealing with big amounts of data etc.). Whereas the concept of *transdisciplinarity* (according to Klein 2010), assumes that elements from different disciplines are adopted and further developed, the interviewee above tries to keep the influence by computer scientists on a '*multidisciplinary level*' and tries to discriminate different goals and epistemic cultures. In this way epistemic standards of the scientometrics community were made visible and were tried to be reinforced, with visualisations playing a role in this process. Other clashes between different epistemic logics were not as prominent as in the example of the computer scientists, but they were also present between statisticians, mathematicians or other natural scientists, social scientists, engineers as well as those that commercially act in the field for example as analysts.

Interestingly enough, it did not seem the case that the visualisations presented and discussed at the ISSI conference were intended to solely or mainly perform within the specific interested scientific peer community. Analysts presented work they had primarily designed for policy or decision makers and re-used the visualisations from the underlying report for the conference paper and presentation at ISSI. In the mind-set of an analyst, this would mean the following: *"I am in this business, because I changed from being a scientist to be a science manager"*. Therefore he says he has to go for a utilitarian approach - *"why is this useful?"* [Int-2, July 16, 01:18-02:30]. The same way analysts have a utilitarian approach towards applying their visualisations in the contexts of reports they have to deliver, computer scientists have a utilitarian approach with scientometricians being the (or one type of) customers. A visualisation tool developed by a French study group called *Gephi* was described as an enabler to transcend disciplinary boundaries, namely to the realm of art: "*You almost can make art with the visualisations*" [Int-7, July 18, 04:42-04:46].

Others embedded their pictures as part of their research results or tools for data analysis and now faced a multi-faceted audience that was interested in a broad range of issues, but hardly

in the reasoning of how the certain visualisation type was chosen. From the sessions visited it could be observed that questions mainly targeted the study structure, methodology, peculiarities in data or were general comprehension questions.

Another dimension of the role of visualisations was opened by the inclusion of a conference theme named *Visualisation and Science Mapping: Tools, Methods and Applications (Topic 8).* This topical strand provided room for presentations that partly changed the audience from scientific peers to possible *customers* or possible users and therefore multipliers of the presented visualisation technique. Following this, there was no dedicated panel or session for visualisation eventually[20]. These authors tended to be computer science specialists or software developers and consequently had different goals and target groups for their work. Their intention was not mainly to contribute scientifically to the field, but rather to convince bibliometricians about the advantages of their visualisation type or to receive feedback how to improve their technology and what new features might be practical.

Another, more implicit target audience for creating the images were the research groups themselves. Supported by the availability of visualisation tools, many scientometricians seem to use the programmes to understand their own data sets, trace possible artefacts, go back and forth between data tables and their representations and eventually decide on one of the visualisation plots as being representative of what the result claim should be. These co-production processes between explorative image production and data analysis have already been described by Mayer 2011 on the case of network visualisations (Mayer 2011a).

Furthermore one of the presenters who also served as an interview partner kept emphasising, that all kinds of visualisations have to be simple and precise enough to be comprehensible by the general interested public which ultimately funds the research through taxes. She insisted that the level of complexity depicted in a scientific representation must not exceed what “her mother” is able to grasp easily and that this kind of practice should be part of science’s responsibility towards society. She criticised that some presenters seemed to demand that their audiences share their epistemic standards. Visualisations should not remain expert images only, but made accessible and readable by a broader general interested public [e.g. Int-8].

[20] As mentioned, there were explicit visualisation workshops and tutorials on the first day and before the classical conference program that are not included in this analysis. Curiously the thematic focus proposed in the call for papers led to the dual organisation of submissions on this topical strand: some were put into the practical demonstration on the preparatory conference days, others were part of other topical strands due to the topical content of their data being visualised (e.g.: “Collaboration Studies”).

Acting as *boundary objects* visualisations are shaping the understanding of researchers in the field of scientometrics and the way scientometricians are understood by others. Yet as opposed to Burri's studies on radiologists (Burri 2008b), the scientometricians observed here did not face the problem of having to justify their position but yet were *renegotiating identity*, as they perceived themselves as somehow competing with e.g.: computer scientists on how the discipline should develop. Technicians seem to cross disciplinary boundaries all the time and tend to emphasise the importance of the produced images having the power to transcend borders between scientific fields internally, but also between scientific and non-scientific entities or the public domain. In the interviews, there were several suggestions made on how this translation process should ideally be supported: by detailed descriptions, labelling and legends, revealing of software settings, parameters and the detailed modulation.

In contrast, scientometricians utilising the same technologies focused more on how to implement them as expert images within the field, with a clear understanding of what only they can *properly* interpret and meaningfully analyse the pictures. Showing them to audience was more illustrative and decorative and to demonstrate their professionalism – similar to what Burri observed in the radiologists' realm: "*Technology and pictures serve as tools to demonstrate professional skills and power, to increase one's reputation and to renegotiate identity*" (Burri 2008b, 35).

Sometimes doubt arose as to whether presenters always intended a common vision or rather wanted to demonstrate what they were able to produce and to manifest their expertise. The common vision aspired here is the negotiation of those who are experts in visualising and reading these images and those who are not. In other cases, the goal was to convince the reader of the final product of an argument and approve the condensate of results within a single or very few pictures. In general, it can be stated, that there are multi layers of visions to these representations, since they not only depict a small section of the data that is being analysed, but are also only one example of the endless depiction versions possible with digital visualisation software. As it was discussed, visualisations are seen more as illustrations of the data than they are seen as the "*serious*" representations. At the same time these pictures are attributed the main power of *telling a story* themselves. All the same, there seems to be contradictory approaches at hand.

Images were transported between different domains in many different ways. While the analysts "re-sell" their report data to a scientific audience, computer scientist and artist want to open science maps for the public, stressing completely different parameters as opposed to producing images for experts in scientometrics. Yet, the features of these science maps are

negotiated here inevitably, by having them accessible and available, applying and presenting them over and over again, getting used to them and finally accepting them as *the* maps of "a global science".

Comparing these science maps to cartographic maps, one interviewee stated that they are moving towards certain universality, but the technology is not ready yet: "*When the first geographic maps of the world were published, people were asking themselves why they would need these things as they had never left their little town anyway. Also, these maps were extremely inaccurate at the beginning, so are the maps of science we are creating now – we are still at the beginning"* [Int-8].

In order to understand how the images become boundary objects, one has to firstly have a look at how meaning is inscribed and described. Visualisation makers either have very clear ideas of what narrative they want to support by using images or they are using the visualisation software tool to first understand their data themselves, using screenshots of particularly aesthetically appealing image results as "eye candies" for the audience. These two application modes make visualisations a powerful tool of 1) dealing with big amounts of data and 2) steering the recipients' attention to those aspects that are important to the researcher. Accordingly, the inscription process is either highly targeted and clearly political or rather arbitrary. On the de-scription side (cf. Akrich 1992) there are many more processes on different layers at stake, starting from the judgement of the results as being reliable or valuable according to the quality of the visualisation, accepting the image as being *the* picture of the totality of the data at hand, or in contrast belittling the value of the visualisation as being minor to the text around it, etc. In the course of this study the description process was not easily observable per se (apart from being part of the personal participant observations made). In many cases, the images were hardly explained, no legends delivered, no data ranges pointed out, no reasoning for the choice of colours, shapes, forms or other stylistic elements given.

Many translation steps have to be taken in order to get from the referents to the representations and further to reach the different audiences. Edwards and others use the metaphor of *data friction*, that is what happens to data when it is handled between different interfaces, as *science friction*, for what happens to scientific meta-data in processes of communication between different science disciplines – "*at some cost in time, energy, and human attention.*" (Edwards et al. 2011, 669). Visualisations as they become boundary objects might be an attempt to preserve the losses of these translation steps.

Distributed as screen shots of outputs from visualisation technology, they are becoming *flat*, *scalable*, *reproducible*, *re-combinable* and *superimposed*, *part of written text* and *tuned to*

geometry (Latour 1986, 19f.). They seem to have all features of immutable mobiles and as such are transcending disciplinary boundaries since they have to perform in different epistemic arenas and are also being created and deployed in multi-disciplinary settings. Yet *immutability* can be contested as being neglected in favour for the high mobility (cf. Stöckelová 2012, 190). Since the images are representations of meta-data, which are representations of other things themselves, the visualisations made are very abstract and highly "reduced" in the sense of Latour's depiction process as *reduction* and *amplification* (see chapter 2.2, Latour 1995). Given the fact, that many visualisations are designed to convince clients of the final reports of the studies they ordered, meaning is being constantly changed when put into different settings. Herewith we are entering a political arena and the question of responsibility arises.

As already mentioned in an earlier mentioned interview statement, there is very little time for professionals in scientometrics to reflect on the visualisations they create. This was also affirmed by another interviewee, when he pointed on the function of visualisation tools to understand their own data: *"Yes, most of the time we use these graphs as part of the analytical process, because we are a company – we do not have enough time."* [Int-3, July 17, 11:25-11:33]. Although using methodological and theoretical concepts and techniques commonly used in their scientific discipline, the arena in which the research results interact is not necessarily a scientific one: *"We never really produce analyses for real scientists – when they do physics, they do physics. When they look at our data, they look at it as research managers.*" [Int-2, July 16, 16:00-16:12].

With the way research managers deal with the analytical process and the way results are presented was described with the following statement: *"The other thing that I recognise in terms of utility is that most of the people who make decisions – people who make policy, people who run organisations – have very little time and they are not going to read a 70 page report that is full of tables and that is full of algebra and is full of theory. The most anyone will ever read – if they are at high level – is going to be maybe three or four pages. So they have people like us who commission reports for them. The report may be 70 pages, 120 pages long, but somewhere at the front of it there is that executive summary. Most people will only read the executive summary and they take it as given that* […] *you checked all the rest of it. You checked that everything else in there has been done properly by the analysts, the statistics are correct and everything else."* [Int-2, July 16, 05:14-06:22].

Posing a question on responsibility and reflexivity to another interviewee resulted in the following answer: *"I wouldn't necessarily say that reflexivity is the strengths of bibliometricians generally.* […] *I think there is a lack of self-critical assessment of what*

people are doing sometimes and it's general so it applies to visualisation, but […] *we also have the same problem with indicators…"* [Int-3, July 17, 08:45-09:36]. There was certain awareness observable, of what the researcher's personal assumptions and the social setting could play a role in the research process: *"People start off with pre-dispositions as to what they are going to investigate, because there is a culture around them that identifies some problems as being more amenable for analysis, some problems as being more important and some problems are identified as being important because they fit the prevailing paradigm and so nobody goes into a piece of work without already having some idea of what they are going to show in the end of it. And scientometricians sometimes seem to forget that* […] *Too much of what people here do is positivist. Far too much is reinforcing and not enough of it is critical and not enough seeks to reveal weaknesses and seeks to identify where improvements can be made. That's part of the problem."* [Int-2, July 16, 03:07-05:10].

Wondering what role the integration of qualitative data plays in understanding quantitative sets and their visualisation, the analyst on the one hand grants importance to empirical data and then equals scientometrics with quantitative approaches ascribing the creation of more accurate analyses as their main task: *"The qualitative elements are absolutely essential.* […] *Some of the scientometricians think that scientometricians should be making decisions about the rest of science. That's not going to happen. So what people here could best do is that they can create better, more informed, more focused analyses…"* [Int-2, July 16, 17:43-18:06].

Summing up, there were quite some reflexive processes observed which seem to be encountering their limits when it comes to pragmatism. Visualisations as boundary objects play roles in enacting disciplinary boundaries while at the same time have enabling properties to maintain and extend the vast multidisciplinarity of the field.

6.4. Performativity and Enacted Realities

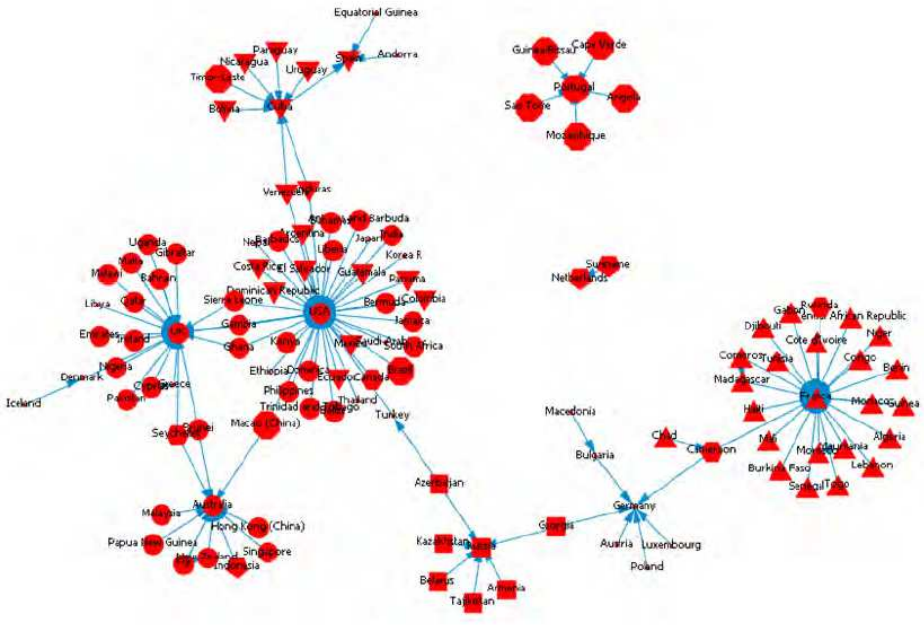
"What's at the front is backed up by the body of evidence, but you don't have to read it. So everything has to be condensed as much as possible. The best way to convince people of something in a short meeting is to turn the words and the numbers into a picture, because the ***picture tells the story****, if it's the right picture."* [Int-2, July 16, 06:22-06:49].

This section treats the visualisations as actants. In the statement above, the interviewee assigns certain agency to his image, asking it to *tell the story* of his research by itself in an efficient way, since people usually read just the executive summaries. Ironically, exactly the one presenter who stated this, used speech bubbles popping up in the slides positioned overlaying images, graphs and tables in his presentation to support what was being

explained orally at the same time. In doing this he took the very visual phrasing of *speaking for themselves* literally, while this is actually contradicting. This shows how unpredictable and yet omnipresent visualisations are as actants.

Contributing to the discussion opened by Law (Law 2009), who analysed PowerPoint presentations and how realities are enacted, the present work suggests having a deeper look into visualisations used on presentation slides and how these elements are performative in a special community. The same way as Law observes for instance national states being *done* in his case, there were similar performative actions observable in the present case. Realities were shaped and enacted within the network of presentational setting, speaker, slide show presentation and the visualisations deployed and they were even interacting with other *realities* – Law exemplarily mentions: electricity supply, conference schedule, etc. (Law 2009, 13).

Scientometricians create realities about science and what is regarded as *real* is shaped by the images in use. Studying Figure 35, we can see students represented as triangles, circles or squares with fixed positions in scattered networks. Although a still plot is being depicted, the title claims to illustrate "student migration", describing non-static movements. What is being performed is a clear idea of *where* to find *whom* at a certain point in time with students as statistical elements. Forming only one of the endless variations of network visualisations in use, it captures one little stone of a multi-layered mosaic of what is taken for granted or *real*.



Picture 2. "Deep channels" in international student migration

Figure 35: Social network diagram from a paper titled "the construction of the academic world-system"; source: Gorraiz et al. 2013b, 398

The figure above does not form a unity but rather an unstructured set of partly connected clusters. Still the image labelling suggests that there is an underlying world system and therefore a unity that by far exceeds the possibilities of the present data set and visualisation form, still it is *out there* once all possible data entities are connected.

Also Figure 36 below states that it is depicting “a base map of science” with an overlay of the data currently analysed in the presented study at ISSI, in order to position their sub-set in the totality of “science”. The kind of reality depicted here is the idea of a whole, complete, although complex thing that can be visualised as a holistic science network.

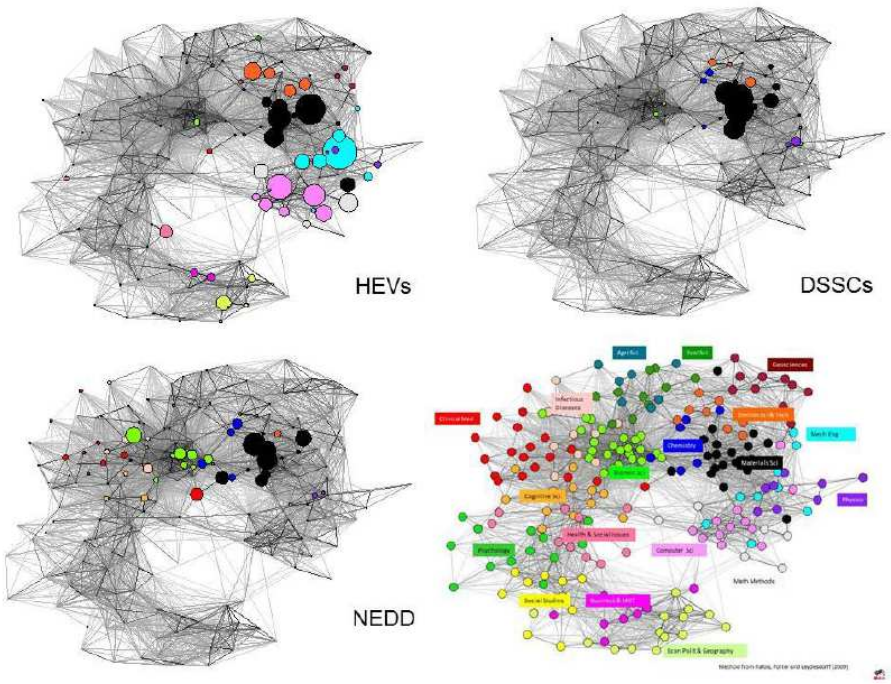


Figure 1. Overlaying the 3 Research Domains over a Base Map of Science

Figure 36: “a Base Map of Science”; Gorraiz et al. 2013a, 1193

There were many attempts to tell the *whole* story by presenting *unity*: a lot of network diagrams eventually take the shape of a “circular totality” of entities that might be closer or more distant in relation to each other but yet are placed within the same unifying globe (when three dimensions are visualised) or circle (when complexity is reduced for one dimension). There is no rule that the totality of a network has to build a circular shape, but algorithms are designed in a way that this is typically the shape that emerges – suggesting completeness or universality in the context of the data set. Having this in mind as the creator of the visualisation, it might not be clear to the reader, that the presented universality represents a certain data set only and not necessarily (actually most unlikely) something complete in the sense that *all* publications or *all* relations between the entity of the network are grasped by

the techniques at work. Maps of science therefore simulate a unity of science by transporting a universality of the data sets that measure publication output.

In a third presentation there was a series of images used to explain publication dynamics in Africa. Figure 37 to Figure 41 show selected slides in the order in which they were presented at the respective conference session.

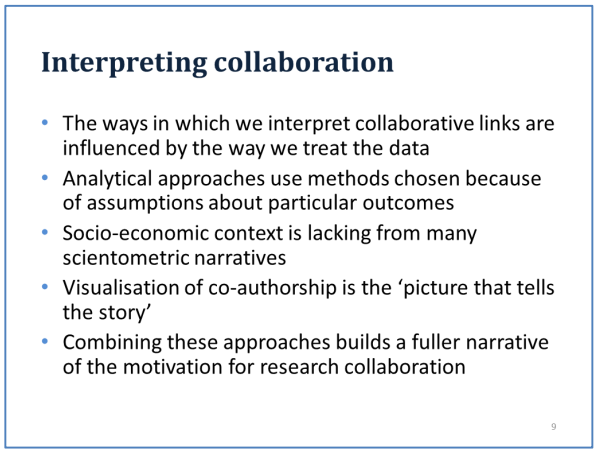


Figure 37: Slide with analytical reflexions (text); source: presentation slide provided by one of the authors

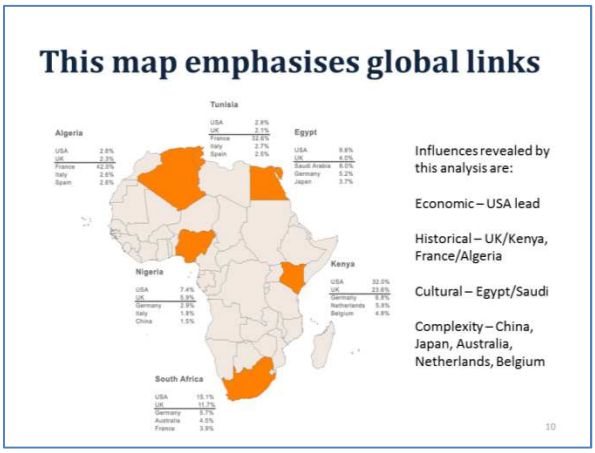


Figure 38: Slide showing a map of Africa; source: presentation slide provided by one of the authors

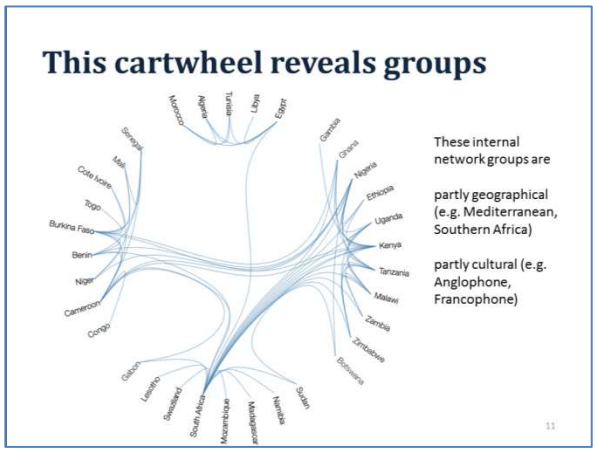


Figure 39: Slide showing Africa as a cartwheel; source: presentation slide provided by one of the authors

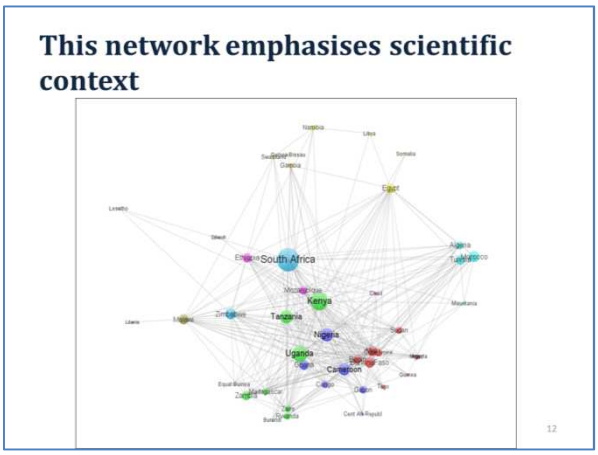


Figure 40: Slide showing a network graph; source: presentation slide provided by one of the authors

The first visualisation depicts those African countries with the most global scientific links, marked by their deep orange colouring on a political map of Africa as opposed to the not recognised countries that are depicted in a pale orange shade (Figure 38). Besides the

countries the authors provide numbers that go along with the decision of why these specific countries were chosen as being the most important entities in this respect, specifying where the numerous links are going as a share of the country's total international co-publication output and emphasising the share with the United Kingdom supposedly because this connection was important in the report the visualisations were produced for and taken from.

The image suggests that there is a clear distinction between the six countries in focus and the rest with no necessity or possibility of graduation. Indicated by the polarised way the data is presented, Africa can seemingly be regarded as consisting of highly connected players and not at all linked ones, or at least those that are not at all worth highlighting within the context, under some certain thresholds. The graphical method visualising this explicitly labels national boarders as demarcation lines between high and low performers, providing the image of the whole geographical area of each country is being covered. Yet, the most productive actors in terms of co-publications are often based in a country's capital city or other urbanised regions and therefore geographically much more concentrated than the highlighted country shapes the image suggests. Consequently, a graph that locates those research *institutions* in Africa that have strong international ties would look decisively different.

Apart from the simplification of reducing African countries to internationally well connected and less connected ones, it has yet to be mentioned that the underlying data is even more complex and that a lot of simplifications in the data must have happened before this visualisation was made. For example it can be assumed, that assigning countries to publications is not always possible in an exact and unique way. Usually each author publishes with reference to the institution he or she is affiliated with, but this does not necessarily mean that this affiliation corresponds to the *country of origin* of the author. Accordingly it is very difficult to conclude on the productivity of whole *national states* – which themselves are social constructs and object to change from time to time[21].

Furthermore, in the imaginative case of one single author mentioning two different affiliations, because for instance he or she has studied abroad and coming back home wants to give credit to both the institutions, it is easily possible that the respective publication is tracked as a co-publication between two countries although it was published by just one author therefore blurring the picture of *international collaboration.*

These are only some few examples of how the decisions with regard to visualisations lead to visualisations that have the power to re-enact some or other realities. This is not to question

[21] In this context the splitting of Sudan into two countries, with the independence of South Sudan gained in 2011 could be mentioned.

the visualisation techniques themselves or blaming anybody for ignoring inevitable problems with data accuracy and interpretation. Yet choices made could be more reflected towards the effects on different versions of what is represented. These issues are not addressed at all in the context of the visualisation that is treated as the main means of communicating results in favour of enabling fast and easy interpretation of the results.

The second slide shows a graph (Figure 39) of a network within a cartwheel. It gives an overview of the publication links between the African countries by placing them in a circular shape with lines of different breadths connecting them – supposedly representing co-publication strength. The way the entities are arranged suggests a completely different picture of Africa, uniting all countries within the same circle. This representation of African countries is not polarising – all elements are treated equally in size and space in relation to each other, only sorted roughly by their geographical position with Northern African countries being arranged on the upper area of the circle, Western on the left, Eastern on the right and Southern countries on the lower area. The way they are arranged leads to an impression that enables the emergence of sub-groups within the continent that are more likely to publish together, as according to the geographical division between the four cardinal points. Also between the sub-regions there are plenty of connections visible with the exception of North-South relations, which seem only to exist between Egypt and South Africa.

The third image (shown on the slide in Figure 40) is a network graph organising the data again according to a completely different logic. This time the arrangement does not go along geographical considerations, but applies one unspecified concept of *centrality*, resulting in a network with the best internally connected elements appearance more towards the centre and elements with fewer links more towards the periphery of the visualisation. The size of each bubble represents a country's co-publications, equals the relative amount of output in comparison to the others.

The two network graphs juxtaposed again tell completely different stories about the co-publication dynamics within Africa. While in the cartwheel all countries are treated equal and Africa seems to be a well organised unity, the network diagram looks much more chaotic. It weighs the elements and therefore gives judgements about the productivity and interconnectedness between the different African countries.

All these visualisations as well as the underlying bibliometric data can only depict a very limited aperture of the *reality* about scientific collaboration taking place, since measuring co-publication output will always only be an *approximation* of collaboration. Yet the authors pointed out that the three images presented provide a decent overview of what is at stake, while pointing at issues and partly discussing them in the slide preceding the results slides

(Figure 37), stating that "*the ways in which we interpret collaborative links are influenced by the way we treat the data*".

The authors also admit their inherent biasedness towards the methods and approaches chosen since assumptions about the possible outcomes have already been present in advance. They also declared that visualising co-authorship is an appropriate way to address their audience with the claim that this process would provide a *"picture that tells the story"* – referring to the visual nature of the process.

The slide that followed the first three data visualisations, Figure 41 below, derived from a different study report and applies the network graph to a geographical map in the background, forcing the data points to be arranged in a way that correspond to their relative geographic positons. It again tells a very different story about co-publication patterns in Africa, not only because the underlying data derives from a different study than the others but because it solely covers Sub-Saharan Africa and not the whole continent.

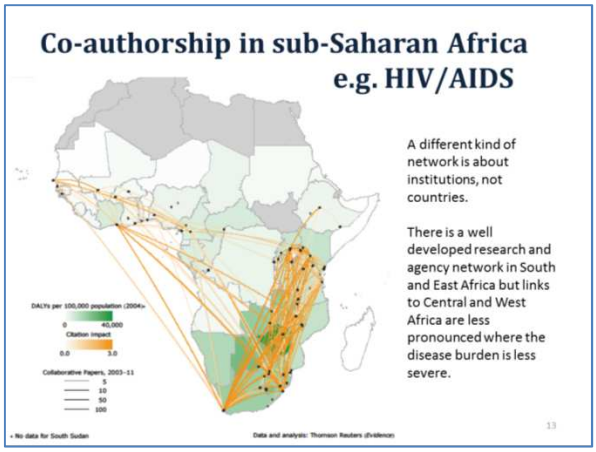


Figure 41: Slide showing a network embedded in map of Africa; source: presentation slide provided by one of the authors

The underlying paper to this presentation was produced for a commercial study on collaboration networks in terms of scientific co-publication activity with some of the main findings reported being 1) the ranking of the six depicted nations (Algeria, Egypt, Kenya, Nigeria, South Africa and Tunisia) as the most globally linked African countries 2) the significantly high centrality of South Africa as origin of the most authors on African international co-publications and 3) the considerably few collaborative ties between Northern or Arab African countries and Southern African or sub-Saharan countries in comparison to ties between actors within the two regions. These results were communicated with the help of visualisations in the form of a map (shown in Figure 38), a cartwheel (visible in Figure 39) and a network graph (another screenshot of the slide show, presented as Figure 40). The

images were taken from the report to the client and used just the way they were in the scientific paper for the ISSI conference.

The three different visualisation types were all produced based on the same data set, but transport three completely different pictures about Africa and the scientific dynamics locatable there. The different ways of visualising the same data and the role they play in *telling the story*, in creating the narrative about what was found in the data, was discussed: *"…there are lots of different ways of visualising the same information. So four of the diagrams that I showed today come from the exactly same data set, but they are showing completely different things.".* [Int-2, July 16, 06:49-07:00] A bit later also the complexity of the stories within each visualisation was emphasised: *"There are series of different stories layered upon one another".* [Int-2, July 16, 09:45-09:49]

Referring to the third graph of the network diagram illustrating network *centrality*, a question of how it comes that Mozambique was the most central country in Africa was posed. The answer was surprising: *"In the original diagram that L. produced, Burkina Faso was right at the centre, which is even weirder. I know it's absolutely weird. And I said to L. "we can't possibly use this, because no-one is going to believe a diagram that says that the most central country in Africa is Burkina Faso – because it obviously isn't! But I say "it's obvious" because I am already prejudiced about which the most important countries are, but I know, that South Africa, Kenya, Nigeria, Egypt, Tunesia, Algeria – they've got a lot of research going on… ".* [Int-2, July 16, 12:00-12:48]

Presumably, the parameters of the visualisation software were then manipulated in a way that Burkina Faso was moved from the centre to somewhere less obtrusive, putting Mozambique to the most central place, which seemed unsuspicious enough to not be questioned in this role. As a reason for this remarkable result created by the visualisation, the following explanation was given: *"Burkina Faso is in the middle because it does not have a single paper that only has Burkina Faso on it. It has no domestic research at all. It has maybe 20-25 papers over the entire period*[22] *and every single one of these papers has other countries on it. It is because somebody did some field work in Burkina Faso. It's usually medical* […] *you will have Switzerland because of WHO in Geneva, so Burkina Faso is a big collaborator with Switzerland? – not really!".* [Int-2, July 16, 13:42-14:35]

Since the authors knew about this effect of health organisations conducting projects in Burkina Faso, with medical scientists later publishing and including their local partners as co-authors on the papers, it seemed inappropriate to keep it as an important representation of

[22] The period of 2000-2012 in the context of the cited study.

international co-publication patterns. Whether and how the case of Mozambique was different to that, justifying it as the new most central African country was not further elaborated. Wondering, whether the authors of the study reflected upon their role in shaping the image of the African continent, the following reply was given: "*Discussions on how the story we are telling is shaping the image of Africa do occur, but we do not have the luxury to think it through and discuss it deeply – we have a customer and most of our research is commercial.*" [Int-2, July 16, 22:00-24:00]. Conclusively, the authors actually indeed were comparably reflective about what they are showing. With the described case it is not attempted to reveal problems with visualisation processes, but to show how different visualisations *enact* different realities.

It seems, as if the presenter himself was not the creator of the network graph, but more involved in the production of the other types of visualisation. Referring to his colleague L., he expressed doubts that this way of presenting the data was meaningful enough to tell a meaningful story. It was anyway emphasised in both, the presentation and the interview, that only the three images together and not individually expressed the results of the study adequately and only in sum provide a meaningful *picture* of the dynamics at stake. *"L.'s network diagram there – that's sort of standard social network analysis – here is South Africa right in the middle. South Africa is the pivot and it is the pivot!* […] *South Africa's centrality is significant but the problem with that network analysis is that… there are all these links going all over the place and it does look like a mess – so okay, South Africa is central, what the hell else am I getting out of this? I have to be a specialist to be able to analyse that. I can't put that in front of a committee"* [Int-2, July 16, 10:14-11:05]

In this example of the three different visualisations of co-publication patterns in Africa we find the construction of *Africa* as a continent comprising of *nation states* manifested as *permanent* and *stable* countries. This is especially interesting considering the fact that South Sudan had split off from Sudan in the period of examination of the study, a process neither mirrored nor reflected in their visualisation. The relative size of the countries in Figure 40 can be regarded as demonstrating their *power*, according to their co-publication output.

Since the authors decided, that depicting Burkina Faso as the most central African country would not fit their *world view*, or to the anticipated one of the audience, a new *picture of the world* was designed and eventually presented as given, with Mozambique now being at the centre. The *corrected* image re-enacts a reality that excludes Burkina Faso as being possibly *leading* in a scientific indicator context. This detail is only one little element of a visualisation that in sum is far more complex and richer.

Thinking in the terms of this author, it is tempting to assume that visualisations might have been deployed at the conference because they were regarded as being inherent to the discipline's common reality: "*It is the enactment of collateral realities that turns what is being done in practice into what necessarily has to be."* (Law 2009, 15). Applied consequently to the above example, we have to ask ourselves whether visualisations on publication strength re-enact realities about power relations.

The case given above was exceptional in the sense that the presenters were very reflexive about the fact that what they were visualising is what they thought as "facts". In other presentations visualisations themselves were hardly ever discussed and very seldom were selection processes reflected upon. For most of the scientometricians, the underlying data is what provides *true claims of reality* while the illustrations tell the story.

With the spread of digital visualisation techniques, scientometricians have not only attempted to increase the number and diversity of forms of graphical illustration of their data, but started creating *maps.* This is being done by either layering data over geographic maps as background or framework for country-related or regionally assignable data or even shaping the idea of *mapping science* itself. Maps have always shaped the way the world is perceived (cf. e.g. Turnbull 2007) and they shape the interaction of this world and the "user" (cf. Vertesi 2008).

Also at the ISSI conference both the usage of maps *for* data visualisation as well as the visualisation of dynamics in science *as* maps was observable. In the following paragraphs an example where certain performativity of the maps which were used is elaborated.

Like any representation we create of the world, maps, whether they depict a geographic setting, visualise science data, or combine the two, have the power to shape the image we have of *reality.* But in everyday life we are confronted with very different maps, in different colour schemes, partly contradicting each other, partly showing completely distinct aspects of the world by using the same techniques. Maps on dynamics in science are comparably new but constantly increasing, as was stated by the last interviewee: "*In the last 10 years science mapping has really exploded"* [Int-8, July 19, 19:06-19:10]

Connecting the issue of what these maps do within the scientometric community and how they can shape how science is perceived, also in contexts that exceed the disciplinary and societal boundaries, the interviewee compared science maps to the historical developments of geographic maps:

"*Just like when we had the very first maps of our world, very few people thought it's useful, because they would never go far out of their little city. So why would they need a map of the*

entire thing? And it wasn't perfect either – if you look at the first maps of the world, they are pretty inaccurate. And I think today also our maps - they are created based on data that is mostly English speaking and they only have a few years in it. You know, science exists since many hundreds of years and no map we have shows many hundreds of years. I think the largest time duration we have is 118 years…" [Int-8, July 19, 19:33-20:16]

With this statement an important aspect, of the way science maps might be communicating a story that is influenced by certain power relations deriving from the underlying data, was raised: The bibliometric citation databases are not only commercial and mainly in English, but they also neither cover an exhausting time period nor do they by far cover *everything* scientific that is published worldwide. It also tells a story about the way science nowadays is considered as being quantifiable, measurable and eventually *visualisable*.

Maps have the potential of providing a *plan* towards a certain target, for example a geographic location in the case of a cartographic map. Analogously science maps and maps overlaid with scientometric information can be considered as targeting a certain objective. The creator intends to provide a *plan* supporting the recommendations he wants to give – with which both, the creator and the map are entering a political arena. To a certain extent, decision makers in science policy resemble military strategists working out their tactics around a map of their target region when they analyse a map of science to understand the situation at present and planning their strategies and policies.

Consequently and inevitably power relations play a decent role. Since the *community* is very small, the core of renowned actors is often present. These *key* individuals also turned out to be the most active discussants in the conference sessions visited. The discussion topics were almost entirely on data accuracy, other application possibilities of the method applied or similar issues. Differences between these key personalities and the less renowned study groups were demonstrated by the latter positioning themselves at the *periphery.* This happened for example through declaraing the quality of their own images as inferior. Cultural differences also played an implicit or explicit role which further highlighted a gap between those that were established in the field and the others that positioned themselves as "newcomers" or multi-disciplinary actors with only a "coincidental" or "fractional" interest and existence in the community.

Given the fact that the conference was international, the presentations varied remarkably according to the nationality[23] of the presenters. A certain way of talking and presenting that

[23] Admittedly, for the context of this study it can only be judged from the names of the authors and their affiliations what country of origin the presenters might have been from and therefore the culture

prevailed seemed to have the same origins like the origins of the discipline and its core organisation (the *International Society of Scientometrics and Informetrics*) – which is Anglophone and North American. This might also be due to the fact that international conferences tend to be in English in general. Whereas multi-disciplinarity provoked concerns in the interviews, multi-ethnicity was no topic at all. Yet cultural issues were present in the panel sessions.

Strongest differences from this imaginative standard was brought in by the Asian participants, most of which were of Chinese origin. Aesthetics were different and other standards of what forms a good presentation seemed to have been present. For example presentations from researchers with Asian background were more likely to end with a final slide thanking for the audience's attention, which was rarely included by other speakers. Also English language use sometimes was an issue – not only did the presenters themselves have troubles reacting to the questions posed in the discussions, but also in the endeavour of extracting information for this study certain presentations had to be excluded from this analysis due to comprehension problems.

Figure 42: Last slide of the presentation of a Chinese study group; source: presentation slide provided by one of the authors

Hierarchies were more perceivable in Asian presentations. Study groups of European or North American authors – as well as mixed ones with authors from any other region – did not emphasise as much the internal power relations between the team members, apart from inevitably listing a first author, who sometimes was also the presenter. Chinese research groups in contrast were never represented by the first author of the conference paper, as far as observed in the sample of this study. The title slide included academic titles and the presenter referred to the professor named (but not present) as their *"Master"* while another one completely forgot to introduce himself but only the professor. Another noteworthy observation was that panels with more Chinese study groups had remarkably more Asian participants as audience in the panels.

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they were most likely socialised in. Obviously, these judgements only give a very blurry idea of the cultural patterns at stake, not only since affiliations are changing through academic movement…

Therefore, cultural geographies are re-enacted in the conference setting, be it in how the scientific community behaves, but also how visualisations perform within this community. Different aesthetics are deployed by presenters from different cultural backgrounds and geographic power relations are also manifested within the visualisations, as shown in the example about co-publications in Africa. Yet the agency of the images does not seem to enjoy a lot of attention. Ideas like the one *of the picture telling the story* and different pictures of the same data telling different stories might be an evidence for incorporated ideas about performativity. One interviewee regarded *performativity* as "*sometimes overwhelming*", remembering one of a metaphor for a *Frankenstein monster*. In this story the object created by science suddenly goes its own unintended ways.

Already before the conference, at knowledge production state, the performativity of the images is relevant, as stated in several interviews: "*These are just instruments. You take the one that fits best to your purpose*" [Int-7, July 18, 13:16-13:23]. Here the underlying data is considered as being superior to their representations as images by the same interview partner, but he ascribes certain agency to them: "*You rely on your statistics. Then you see these visualisations and if the visualisations do not match, then you begin to wonder, then it opens up new domains of new questions. It's not straightforward. Of course these visualisations are also performative."* [Int-7, July 18, 04:00-04:26]. The role of visualisations in this respect was described as being a potential source of reflection by a different interview partner: *"Those maps are also a starting point for discussion to verify whether the pictures that people have in mind are correct or not"* [Int-4, July 18, 16:04-16:18]. Later they were also described as a source of *knowing* themselves: "*Another additional value could be that the user agrees with the general structure of the map* […] *but they see some very interesting new facts that they did not know of. This can lead to information discovery. They can re-shape their picture they have in mind. So they can learn from the maps*" [Int-4, July 18, 16:25-17:10].

7. Conclusions and Outlook

In this study is has been shown how practices with visualisations are performative, in the way that arguments are being made by *letting the picture tell the story*. Further, the discipline has been opened up and defended at the same time, also by the use of visualisations as boundary objects (Burri 2008b), which perform in their quality as immutable mobile (Latour 1986) and are treated as expert images with computer scientists defining scientometricians as their *users*. Visualisations were understood as social technologies and different functions

of visualisations in scientometrics were observed. They are designed to let their spectators make their way through science – in the broadest sense, but not without inscribing own ideas about the world, science and society that go along with it. The imageability of these visualisations derives from various assumptions about their usage, be it to underline an argument, to visually enrich a slide show presentation or to enable deeper insights and faster understanding of one's own data with publishing representations afterwards as findings, not necessarily as a product of serendipity. Similar to other studies it can be concluded, that epistemic foundations are often fragile (cf. Mayer 2011a, 371), it could be advisable to accept and better acknowledge inherent multi-disciplinarity of the field itself and the necessary expertise for creating visualisations even at engagement and deployment state.

So was it worth all the effort? What have we learned from this ethnographic case? What new findings can be added to any scientific discourse? At first sight: not much. There have previously been case studies conducted that described how visualisations become boundary objects or immutable mobiles (Burri 2008b; Mayer 2011a), what metaphors are deployed and how visualisation processes are negotiated (Mayer 2011b), how (expert) images are being instrumentalised to make claims – also in public spheres (Beaulieu 2002; Dumit 1999); how realities are consciously and unconsciously being created through representations (Law 2009) and many other ethnographic case studies observing science in the making and in its interaction with different publics. Yet the present observations could be a valuable starting point for better understanding of dynamics that might concern many scientific disciplines, with scientometrics being one of them and at the same time triggering these developments in various aspects.

What Mitchell coined as the *pictorial turn* is visible in scientometrics just as in other disciplines. The prevalence and open accessibility of visualisation techniques and tools enables their wide usage and spread, often replacing words in contemporary culture and developing to be "*the most dominant mode of expression in our time*" (Mitchell 2005, 32). Another tendency is the *Mode 2 of Science* that was described as an increase in accountability, trans-disciplinarity, contextualisation and increase in institutional heterogeneity (see Gibbons et al. 1994; discussed in more detail in chapter 2.1.1). All those elements had already been observed to be present to some extent in the field of scientometrics earlier (Martin 2011). This study has now revealed how visualisations have potential to play a role in the transition towards *Mode 2*.

Accountability is not only stronger demanded by funding authorities and contracting entities of bibliometric studies, scientometrics itself is a field that enables *accountability* over other fields, by delivering performance statistics. Only with these standardised figures can data

become comparable and figures packed into diagrams, graphs and visualisations to promote findings. These visualisations are then an enabler for increasing *trans-disciplinarity*. Not only because the increased usage of visualisations required new researchers from other domains to enter the already quite multidisciplinary field (e.g.: computer scientists), but also as the visualisations themselves enable transdisciplinary collaboration as they become *boundary objects* (Star and Griesemer 1989). Visualisations can serve as these objects and enable depictions of bibliometric results to transcend different disciplinary worlds, yet not always without problems and changes in focus and meaning. High demands of the contextualisation of research results also asks scientometricians to argue how their research is useful and considering their "busy costumers" in research policy, results have to be communicated as efficient as possible. As we have seen, visualisations play a crucial role here since the researchers were convinced, that *the picture tells the story*.

It was also observed how it is a specificity of this community to visualise in a dual process of first having data representing dynamics in science and visualisations again representing this data. There are double inscription and description processes at stake, enabling the researcher to understand the own data better, but to eventually add an additional layer of abstraction.

To answer the guiding research question, it was found that collateral realities are enacted by representing ideas about the *world* as manifested in the presented visualisations like the case of Africa's co-publication centrality. What was depicted in science maps was hardly contested or questioned. It was not discussed whether or not images are more meaningful than the data or the processes giving its shape nor how they complement the data nor how they perform in comparison to other images. In this sense visualisations become referents to an envisioned society that is made a collateral reality *incidentally* and *unintentionally* (Law 2009, 1).

All the practices, functions, discussions, engagements, deployments and enacted realities at stake are effects of this quality any representation inheres. Visualisation in scientometrics are performing in political environment because they form a colourful reality of an abstract construct that is a product of a long series of previous representation and translation steps and that have been elaborated due to a need for analytical evidence in decision making in science administration. Looking at this aspect behind the concept of performativity, it was observed that with the visualisations at stake, realities were enacted, negotiated and stabilised and in this sense the attempts of picturing "what we think is out there" are consequently contributing to form "what is out there" – these images and social order are

being co-produced. This is not at all claim against using visualisations, but to the implementation of reflexivity processes during their production, engagement and deployment.

What does this mean for the scientometrics community? The specific role this discipline adheres to is deeply connected with how science is perceived in general. Based on statistics, science policies are negotiated, funding is distributed or even personnel decisions are made. Doing research about science opens possibilities of shaping perceptions of what science *is*, and so do scientific visualisations about science, serving as mediators for statistical results.

Images should be more acknowledged for their performativity and, following Amann's and Knorr-Cetina's conclusion, should be the starting point for discussions, rather than seducing to accept them as definite proof of evidence: "*Images (visual evidence) do not function in the literature in the way one might assume; that is, by reducing the indexicalities of the text, by displaying the data unequivocally, by adding the certainty of proof which the text can only refer to, but not "show". Quite to the contrary. Images, perhaps more than texts, provide infinite opportunities for visual exegesis, thereby functioning to* ***keep the discussion open, not closed****"* (Amann and Knorr-Cetina 1988, 163).

Referring to Collins, saying "[a] *prerequisite of any study must be an acknowledgement of the importance of all elements and uses of scientific knowledge, not only formal and informal elements, but the political, persuasive, and emotive, even the intangible and the unspeakable."* (Collins 1974, 184). This study therefore reminds one that visualisations are a specific form scientific knowledge and equally not to be underestimated for their performativity, persuasiveness, inherent (political) desires (cf. Mitchell 2005), and emotive power. Although they are often utilised to circumvent or enhance textual representations, it is possible to *speak* about them.

Using visualisations in scientometrics is therefore an inherently political undertaking that is accompanied by certain obligations towards different audiences at stake. This study is only cursorily touching on questions about how any researcher for science dynamics bears responsibility in a broader societal context. Yet the question of responsibility, especially in the context of image deployment and the seductive mechanisms that come along with it, is certainly one that deserves further treatment in broader studies.

The focus of the present study was rather an observation of what role visualisations play in the scientometrics discipline *internally*. Equally, there are politics at stake. Representatives of different disciplines use images as boundary objects to demonstrate their expertise, to convince their users, to seduce their audiences to take their data as finite. Multi-disciplinarity is enacted and power relations negotiated, with visualisations as *gladiators* in transepistemic

arenas. Yet the performative power of their visualisations is hardly broached as an issue, at least within the conference setting.

Since the community has to deal with an increasing amount of data, the visualisations in observation were to some extent intermediaries and mediators (for a distinction see Latour 2005) between scientists and the data. Hence the role of visualisations can be expected to gain importance. How these visualisation mechanics as a tool shape knowledge production and what they change in the communication and interaction with results across the different boundaries could be studied in more detail. The perspective chosen for this study observes how visualisations as objects become actants within a certain community. The images themselves, their techniques of representation and aesthetic considerations do play a role in how the images perform, but were not in focus for this study. The contents of visualisations in scientometrics and their relations to the research contents of the state of the art discourse in the field would be another interesting research topic itself.

Eventually it has to be borne in mind that the whole focus of the study systematically ignores the “non-users” of visualisation tools in the field. The possibility, that there might have been scientists who consciously refused deployment of visualisations in the same contexts their colleagues did was completely excluded from this field work. Their reasoning and approaches for understanding big amounts of data, persuading science policy or decision makers and the dissemination of their research results without the help of performative and seductive images would be another excellent topic for a successor study.

Drawing back to the pun in the title of this thesis, whether we eventually have gained a picture of science, has to be answered in two ways. In the literal sense of the sentence we have viewed many visualisations at the scientometrics conference. We have caught a glimpse of what kind of pictures are being produced, engaged and deployed in a certain field of science and in a broader sense, gained an impression of how this field of science visualises its outcomes and interacts with them in various epistemic arenas. In the second sense of the question referring to whether a thing called “science” was made visible. A single comprehensive *picture* of this thing or its dynamics was not necessarily gained, although there were attempts observed to ascribe some kind of universality to science maps. It shall be left open at this point whether we will ever be able to gain a picture of science with the help of visualisations in the literal sense.

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9. List of Figures

10. List of Tables

11. Annex

11.1. Abstract

The present work on the performativity[24] of scientific visualisations deals with the communication and negotiation processes within a knowledge community. In particular it focuses on the community of researchers and practitioners in the field of scientometrics and informetrics, taking a case study of some presentations of participants of *the 14th International Society of Scientometrics and Informetrics Conference*, which took place in July 2013 in Vienna, Austria.

This study creates an ethnographic snapshot of a research community and its imaging habits to understand how visualisations are performative by enacting realities, how they transcend disciplinary boundaries and how visualisation techniques are socially shaped. The visualisations in observation ranged from simple graphs, diagrams, photos or sketches to visually, technically and therefore interpretability-wise more complex representations of scientific data (edge-bundling visualisations, network graphs or interactive or presentations). The methodological approach consists of a content analysis in preparation for the fieldwork by scanning the conference proceedings as well as ethnographic field work including participant observation as well as short ethnographic interviews during the course of the ISSI'13 conference.

With the results it can be argued that visualisations in scientometrics contribute to a change of knowledge production that has been described as Mode 2[25] of science, by being performative and therefore enacting realities, by forming boundary objects[26] to both, defend the field of scientometrics and also enable trans-disciplinarity[27]. Visualisations in scientometrics should therefore be acknowledged for their performativity and used as discussion elements, rather than serving as evidence. It is recommended that further research could delve into how far this is valid for other scientific areas.

[24] In the sense of Law, 2009.
[25] Cf. Gibbons et al., 1994.
[26] Cf. Star and Griesemer, 1989.
[27] In the sense of Klein, 2010.

11.2. Kurzfassung

Die vorliegende Arbeit zur Performanz[28] wissenschaftlicher Visualisierungen behandelt deren Rolle in Kommunikations- und Verhandlungsprozessen einer Wissens-Gemeinschaft. Der Fokus wird auf die Forscher und Praktiker im Feld der Szientometrie gelegt, indem sie die Präsentationen der TeilnehmerInnen der 14. Konferenz der „Internationalen Gesellschaft für Szientometrie und Informetrie“ (*International Society of Scientometrics and Informetrics;* ISSI), die im Juli 2013 in Wien stattgefunden hat, als Feldstudie hernimmt.

Diese Studie erstellt einen ethnografischen Schnappschuss einer Forschungsgemeinschaft, ihrer Verbildlichungsgewohnheiten, sowie der Art und Weise wie Visualisierungen eingesetzt und diskutiert werden, um zu verstehen, wie diese Visualisierungen auf performative Weise Wirklichkeiten inszenieren, wie sie disziplinäre Grenzen überschreitbar machen und die eingesetzten Darstellungstechnologien sozial geformt sind. Die beobachteten Visualisierungstypen reichen von einfachen Graphen, Diagrammen, Fotos oder Entwürfen zu visuell oder technisch und daher auch interpretativ komplexeren Repräsentationen wissenschaftlicher Daten (wie zum Beispiel *edge-bundling* Visualisierungen, Netzwerk-Grafiken oder interaktive Darstellungen). Der methodologische Zugang besteht einerseits aus einer Inhaltsanalyse der Konferenz-Proceedings in Vorbereitung auf die Feldarbeit. Weiters baut die Arbeit auf teilnehmenden Beobachtungen und kurzen ethnografischen Interviews auf, die im Zuge der ISSI 2013 Konferenz durchgeführt wurden.

Mit den Ergebnissen wird dargelegt, wie Visualisierungen in der Szientometrie dazu beitragen, wie Wissensproduktion sich in eine Richtung verändert, die als *Mode 2*[29] beschrieben wurde. Dies geschieht durch die Performanz der Bilder und der dadurch geformten Realitäten, aber auch in ihrer Rolle als *boundary object* (Grenzobjekt)[30] in der sie sowohl das Feld der Szientometrie verteidigen, als auch Transdisziplinarität[31] ermöglichen. Insofern sollten Visualisierungen in der Szientometrie in ihrer Performanz und als Diskussionselement anerkannt werden und weniger als Beweismittel für bibliometrische Resultate. Es könnte nützlich sein im Zuge von Folgestudien zu erforschen, inwiefern dieses Ergebnis auf andere Felder übertragbar ist.

[28] Law, 2009
[29] Gibbons et al., 1994
[30] Star und Griesemer, 1989
[31] Klein, 2010

11.3. Conference Programme

14th International Society of Scientometrics and Informetrics Conference
15th–19th July 2013
Vienna, Austria

Registration (Aula)
Monday–Thursday 08:00–18:00

Monday 15 July	**09:00–16:00** Doctoral Forum								
	09:00–12:00 Parallel Tutorials 1 & 2				**13:00–16:00** Parallel Tutorials 3 & 4		**16:15–18:15** Parallel Workshops 3 & 4		**18:30–20:30** Reception Vienna University Arcade Court
	10:00–12:30 Workshop 1				**14:00–16:00** Workshop 2				
Tuesday 16 July	**09:00–10:30** Plenary 1: - Opening ceremony - Keynote: Social Network Analysis - Intro to ORCID	10:30–11:00 Coffee Break	**11:00–12:30** Parallel Sessions	12:30–13:30 Lunch	**13:30–14:30** Poster Session 1	**14:30–16:00** Parallel Sessions	16:00–16:30 Coffee Break	**16:30–18:00** Parallel Sessions	**18:30–20:30** Vienna Guided Tour
Wednesday 17 July	**09:00–10:30** Plenary 2: - De Solla Price Award - The Wondrous World of Bibliometric Indicators	10:30–11:00 Coffee Break	**11:00–12:30** Parallel Sessions	12:30–13:30 Lunch	**13:30–14:30** Poster Session 2	**14:30–16:00** Parallel Sessions	16:00–16:30 Coffee Break	**16:30–18:00** Parallel Sessions	**19:00–23:00** Conference Dinner Vienna City Hall
Thursday 18 July	**09:00–10:30** Plenary 3: - Individual-Level Evaluative Bibliometrics	10:30–11:00 Coffee Break	**11:00–12:30** Parallel Sessions	12:30–13:30 Lunch		**13:30–15:00** Parallel Sessions	15:00–15:30 Coffee Break	**15:30–17:30** Parallel Sessions	**17:30–18:00** Closing Ceremony (incl. Garfield Price Award and Poster Award)
Friday 19 July	**09:00–18:00 All Day Social Event:** **Bus and Boat Trip to the Wachau Region** (Romantic Danube Valley)								

Source: http://www.issi2013.org/Images/PObig.jpg

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Having mentioned my educational leaves, I would like to take the chance to express my compliments to the Austrian social system and its offers for continuous education. I feel very lucky and grateful that I met the requirements to apply and to have received financial support and time for my endeavour.

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12. Curriculum Vitae

Isabella E. Wagner

Work Experience

Project Manager and Researcher
Centre for Social Innovation, Vienna (since 2011)

- Project Management
- Bibliometrics and co-publication studies
- Internationalisation of science
- Science policy and development
- Project communication and dissemination

> http://www.zsi.at

Vice Chair
Austrian Network for Information and Communication Technologies for Development, Vienna (since 2010)

- Science partnerships
- Communication and media work
- Impact analysis and monitoring

> http://ict4d.at

Library Assistant
Library of the University of Applied Sciences,
St. Pölten (2006-2009)

> http://www.fhstp.ac.at/campus/bibliothek

Education

University of Vienna
Vienna, Austria
Master Science-Technology-Society
(MA – grad. 2014 forthcoming)
Bachelor International Development

University of Applied Sciences
St. Pölten, Austria
Master Media Management
(Mag. FH – grad. 2009)

Tomas Bata University
Zlín, Czech Republic (semester abroad)

Grammar School
Krems an der Donau, Austria
with Focus on Roman Languages
(grad. 2005)

Language Skills

German	native language
English	Level C2, CAE (2007)
French	Level B1-2
Spanish	Level B1
Portuguese	Level A2
Czech	Level A1-2, semester abroad in Zlín (CZ)
Latin	

Contributions

Smoliner, Stefanie und Wagner, Isabella (2013): Evaluation of the WTZ-Programme; conference paper at the fteval conference 2013

Schuch, Klaus; Dall, Elke und Wagner, Isabella (2012): The Potential of Transfer of Bilateral R&D Projects towards the European Framework Programme for Research and Technological Development, in: Loudin, J. & Hochgerner, J.: Social and Cultural Dimensions of Innovation in the Knowledge Society, Filosofia, Prague

Duque, R.; Wagner, I.; Shrum, W.; Mbatia, P.; Palackal, A.; Dzorgbo, D. (2010): The Making of Brother Time, Kenya 2009: Conducting video ethnography in developing countries; Conference Paper

Tomitsch, M.; Konzett, M.; Wagner, I.; Sturm, F.; Bolin, A.; Grechenig, T. (2010): Stories from the Field: Mobile Phone Usage and its Impact on People's Lives in East Africa; conference paper

Wagner, Isabella (2009): Nollywood – Film Industry in Nigeria and its Marketing Prospects; Master Thesis in Media Management