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Barriers to the exchange of hydrometeorological data in Europe: Results from a survey and implications for data policy

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SUMMARY

A survey has been conducted to understand what are the perceived barriers to the free exchange of hydrometeorological data in Europe. A total of 127 questionnaires were received of which 61 were completed by data providers and 66 by data users in 32 European countries with a total 631 entries (i.e. assessments of barriers affecting one data type) in the questionnaires. The responses have been analysed in terms of what barriers are perceived to exist, whether there are differences between research, industry and administration, between the West and East of Europe, and between different data types. The responses suggest that the most important barriers are of economic nature. The majority of the data users think there exist economic barriers to the free exchange of the data (significant at the 0.01% level) while the data providers give mixed results. Out of the types of institutions, the research institutions give the most significant response of the existence of economic barriers, followed by industry and administration. For the East European countries economic barriers are considered a much more serious problem than for the West. Out of the data types surveyed, precipitation and geospatial data are considered to be the most critical in terms of costs. The differences between the perceptions of data providers and data users depend strongly on the type of barrier. The differences are smallest for legal barriers (such as licensing of data), followed by the economic barriers and are largest for the practical barriers. Conflict of interest is another potential barrier examined in the survey. Suggestions are given on how to address the economic barriers in a European context.

Introduction

Hydrology, as an observational science, requires systematic data collection programs to provide the basis for understanding hydrologic systems and document changes over a variety of temporal and spatial scales (NRC, 1999). It is by observing changes over time, and comparing observations from different sites, that hydrologists develop an understanding of hydrological processes and responses (Blöschl, 2006). This understanding is embedded in, or underpins, models, guidance and advice provided to water managers and policy makers. Efficient routes to data sharing enable both advances of hydrological science in general as well as the development of more effective strategies to approach water resources problems in practice. Therefore, the issue of free and unrestricted data transfer/exchange from the institutions and entities which collect the data (*data providers*) to the community which make use of them (*data users*) has always been a central issue in hydrology. "Free and unrestricted exchange" has been defined as "exchange which is non discriminatory and at no more than the cost of reproduction and delivery, without charge for the data and products themselves", based on the principles of WMO Resolution 40.

The question of the free and unrestricted exchange of hydrometeorological data is particularly important to advance understanding and better management policies in the case of locally rare events, such as flash floods. Analysis and understanding of localised and rare events generally requires a broader spatial context and data exchange to monitor events, to capitalise knowledge and to evaluate different management strategies (Creutin and Borga, 2003; Borga et al., 2008).

The issue is becoming even more important today, under the influence of at least two major trends. One large-scale trend is represented by the growing concern, at all levels, about the impact of human-induced interferences on the water cycle, ranging from land use and land cover changes to greenhouse-induced climate change (Blöschl et al., 2007; Milly et al., 2008; Sivapalan and Samuels, 2009; Blöschl and Montanari, 2009). A deeper understanding of the link between hydrological variability and economic growth – and of the cost of being "hostage to hydrology" (Ashley and Cashman, 2006; Stern, 2007) – puts a premium on better

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water resources management and infrastructure, and hence on improved data availability. A second major driver is represented by the emerging way of looking at knowledge as a shared resource, a complex ecosystem that is a *commons* – a resource shared by a group of people that is subject to social dilemmas (Hess and Ostrom, 2007). The rising tide of digital technologies that allow global, inter-operable distribution of information have most dramatically changed the structure of knowledge as a resource (NRC, 1997; Uhlir and Schröder, 2007).

However, anecdotal evidence and everyday experience shows that limitation to free hydrometeorological data exchange is growing and a number of barriers severely constrain the free transfer of data and observations. Here again it is possible to recognise a historical trend and large-scale economical and political drivers. In most countries, data collection (i.e. field measurements, quality control, electronic encoding and storage) is the duty of national public institutions. But, in many cases, within a single country several other bodies may collect a substantial proportion of the information (hydropower producers, irrigation companies, inland navigation companies and meteorological businesses being amongst the most noticeable examples). These organisations, which support the cost of the collection of data from their own private field network and for their specific purpose, are inclined to consider that they are full owners of the data sets, which others argue should be considered as a common public good (Stiglitz et al., 2000). This applies also to companies that developed the monitoring networks when being publicly funded agencies and later, after privatization, tend to sell the data as private owners of the data resources (Uhlir, 2004).

It should be noted also that, during the last decades, several National Hydrological and Meteorological Services (NHMSs) faced a growing financial pressure following reductions in traditional government funding (Freebairn and Zillman, 2002a,b). NHMSs started therefore considering their information holdings as a commodity used to generate short-term revenue, asserting monopoly control on certain categories of information to recover the costs of its collection or creation. These arrangements give the reasons for the development of conflicts of interest in the operations of the data providers, which tend to preclude other entities from developing markets for the information or otherwise disseminating the information in the public interest. Weiss (2002) termed this a 'cost recovery model' and pointed out that European countries have experienced a wider and deeper development of this model (in contrast, for instance, to the United States), due to their restrictive government information practices (see also Saarikivi et al., 2000). Clearly, these arrangements have provided the reasons for several types of barriers, which negatively affect the exchange of data throughout Europe.

Conflict of interests and the development of the cost recovery model are not the only factors limiting data exchange in Europe. As an example, data sharing has declined in the last two decades among East European countries which were formerly associated with the Soviet Union. This is an unintended consequence of the political changes in the region, which have dissolved the legal and institutional basis for data sharing arrangements that were in place before the collapse of the Soviet Union (Tammelin, 2007).

The issue of access to and exchange of hydrometeorological data and products has been extensively debated and regulated in the framework of the different statutory bodies, such as the World Meteorological Organisation (WMO) and the European Union (EU). It is important here to recognize the diversity of circumstances in which agencies collect and distribute water resources data, which is much higher than that in which National Meteorological Services collect weather and climate data. Nevertheless, it is interesting to consider the policy and practice used for making available meteorological data and information as they have been stated in Resolution 40, adopted by the Twelfth WMO Congress in 1995. Resolution 40 has become the key guideline now used for the international exchange of environmental data and the global practice of meteorological services. Hydrological data and products were not covered by Resolution 40 and so, in 1999, the Thirteen Congress adopted Resolution 25, which is consistent with Resolution 40, but applies to hydrological data and products. However, Resolution 25 has no list of variables and formats which would characterise what is considered as essential data and products for hydrological studies and water resources management.

In Europe, the Aarhus Convention (The United Nations Economic Commission for Europe (UNECE) Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters) provided a framework for the public rights regarding access to information and public participation. The Convention focuses on interactions between the public and public authorities. Article 4 of the Convention secures the public access to environmental information from public authorities and, in some cases, from private parties, within a reasonable amount of time. Further, Article 5 imposes parties and public authorities to collect and disseminate environmental information (Janssen and Dumortier, 2003).

A number of European initiatives have been launched during the last decade to implement the Aarhus Convention: the broad-reaching Directive on the Re-use of Public Sector Information (2003) (the PSI Directive) (European Commission, 2003a), the Directive on Public Access to Environmental Information (2003) (European Commission, 2003b), which obliges public authorities to provide timely access to environmental information, and the specific directive establishing an Infrastructure for Spatial Information (2007) (the INSPIRE Directive) (European Commission, 2007). Two initiatives were originated by this legislation framework: the INSPIRE project and the WISE web-portal. The INSPIRE "Infrastructure for Spatial Information in Europe" is an EU initiated cooperative project between DG Environment, EUROSTAT and the Joint Research Centre. The aim has been to trigger the creation of a European spatial information infrastructure that delivers integrated spatial information services to all users. These services should allow the user to identify and access spatial or geographical information from a wide range of sources, from the local level to the global level, in an inter-operable way for a variety of uses. The target users of INSPIRE include policy makers, planners and managers at European, national and local levels as well as citizens and their organisations. WISE – the Water Information System for Europe – is another co-operation project involving European environmental institutions as the European Commission (in particular DG Environment, the Joint Research Centre and EUROSTAT), the European Environmental Agency and the Member States in modernising the collection and dissemination of information on water policy across Europe. The output is a new web portal which provides access to data and reports related to the Water Framework Directive, the Urban Waste Water Treatment Directive, and the European Environment Information and Observation Network on Water (EIONET/Water).

Two further efforts are worth being mentioned here. One is represented by the Shared Environmental Information System (SEIS) initiative, which intends to provide an integrated platform to connect all existing data gathering and information flows related to EU environmental policies and legislation into a shared and common system. The other is represented by the activities of the Group of Earth Observations (GEO) which provided an overview of international data sharing laws, principles, and policies. More specifically, the GEOSS 10-Year Implementation (http://www.earthobservations.org/geoss_dsp.shtml) recommends a draft set of implementation guidelines for the GEOSS Data Sharing Principles and provides suggestions for the Earth Observation data policy,

i.e. a policy that outlines the rules governing data availability and access, and include guidance on how these data are to be managed and archived.

As identified by these initiatives, there are a number of data that are also required and used by water managers and by researchers in the field of hydrometeorology that are not to be included in INSPIRE and WISE, and there are barriers to data exchange that cannot be easily overcome even when INSPIRE and WISE will be fully implemented. In spite of the significance of the issue, relatively few quantitative studies have analysed the problem of data sharing in hydrometeorology. Most of them are focused on the economics of meteorological information (e.g., Freebairn and Zillman, 2002a,b; Pettifer, 2008; Leviäkangas, 2009). Among the hydrology-oriented analyses, Grabs (1997) explored the data access problems from the viewpoint of the Global Runoff Data Centre (GRDC).

Against this background, the objective of this paper is to provide an analysis of the mechanisms and barriers which limit the access to hydrometeorological data in Europe, and to understand the reasons and motivations for these barriers. The asymmetry existing in the production of and access to hydrometeorological information is a key feature of tensions triggered by diverging views or visions among data providers and data users. This asymmetry needs to be recognized in the analysis. This study hence uses a survey method that explores the different perceptions of data providers and data users. In an effort to provide a broad coverage of the European institutional and organisational frameworks, the survey was conducted for all European countries. Different types of barriers and reasons for barriers were identified, based on literature analysis and discussions within the HYDRATE project members. The barriers considered are *legal*, which includes licensing of data; *economic*, which includes pricing of the data; *practical*, such as excessively long delivery times or inconvenient data format (e.g., data provided in paper format only). The reasons for the barriers are *economic*, such as when data providers have to cover some of the expenses related to the data by earning an income from selling them; *conflict of interest*, such as when providers sell their products based on the data; and *misuse awareness*, such as redistribution of the data by the data users. The economic considerations appear here as a barrier to data users and as a reason for data providers to apply charges.

The final objective is to provide indications for a more effective data policy in hydrometeorology, indicating where are the main perceived blockages to assist in policies that may address them. In an attempt to identify patterns of data policy and data exchange perceptions in Europe the data were stratified in: data providers and data users; type of institution (research, industry and administration); country (West and East Europe); and type of data (streamflow, precipitation, radar, geospatial, others).

The paper is structured as follows. The next section describes the survey design. Outcomes of the analysis of the survey are reported in "Results" and discussed in "Discussion". Conclusions and implications for data policy are reported in the last section.

Survey design

In order to characterise, throughout Europe, the perceptions of data users and data providers on barriers to data exchange, a survey was designed to gather the relevant information. We define the concept of barrier to data transfer/exchange in the following way: characteristics – either real or perceived – of legal, economical, technological or institutional context which work against the free and unrestricted transfer of hydrometeorological data, either because they impede demand, by acting as a disincentive or obstacle for data users to engage with data providers services; or because they impede supply, by acting as a disincentive or obstacle for data providers to provide free and unobstructed access to data.

The survey was conducted by mail to cover a wide geographical area at relatively low costs. As a target area, all countries of the European Union were selected plus countries that can be considered to be part of Europe from a geographical perspective (Fig. 1). In order to increase the response rate, the survey was designed as a two-level process. At the first level, the survey was administered by a network of contact people in each country. The contact people were mainly (but not exclusively) from the local universities. We asked them to identify institutions from the Administration, Research and Water Industry in his/her country, send them the questionnaires, and encourage them to fill them in (second level). We also asked them to personally talk to the data providers to assuage any concerns they might have about completing the questionnaires. In some cases, the contact people received a small honorarium for their help in organising the survey. By means of this cascade process, at least one institution (but generally many more) in each country was surveyed with the exception of three (non-EU) countries in which no contact could be established. As anonymity was guaranteed to all participants, all results of the survey are reported in a lumped way that does not allow identification of individual institutions or persons.

Survey material and questionnaires

The material presented to the potential respondents consisted of a side letter and the actual questionnaire (Appendix). The side letter included a request for cooperation (a brief introductory paragraph highlighting the reason for the survey, voluntary participation, confidentiality, and willingness to provide a copy of results to respondents if desired), and instructions (a simple description of the meaning of the items in the questionnaire).

The questionnaire consisted of two, almost identical tables, one designed for the data providers and one for the data users (Tables A.1 and A.2). The similarity of the questionnaires was to ensure that we were able to compare the relative perceptions of the two groups. Each questionnaire stated the following potential barriers and reasons for barriers:

- *Legal restrictions* related to the circulation of data that are accessible only to some (often governmental or institutional) organisations, and not to external users (such as stakeholders). For example, in some European countries, access to some sort of geospatial data is restricted for military reasons.
- *Economic reasons* related to the pricing/costs of collecting the hydrometeorological data (often very expensive) and/or the charges applied for the time required to make the data accessible (often a minor expense).
- *Conflict of interest* may arise when data providers develop and sell their own value-added products from the raw data they obtain, so there is a disincentive for them to provide data to potential competitors.
- *Misuse awareness* when data providers fear economic misuse of data by users (e.g. users reselling the data), or technical misuse (e.g. users to develop their own "inappropriate" design values) and prefer to provide end products (e.g. T year floods) to the users.
- *Data quality awareness* when data providers are concerned about public scrutiny over their own products (e.g. inconsistent rating curves).
- *Practical problems* when data providers lack resources and/or staff to supply the data.
- *Other,* e.g., privacy issues of person-related information and potential political issues.

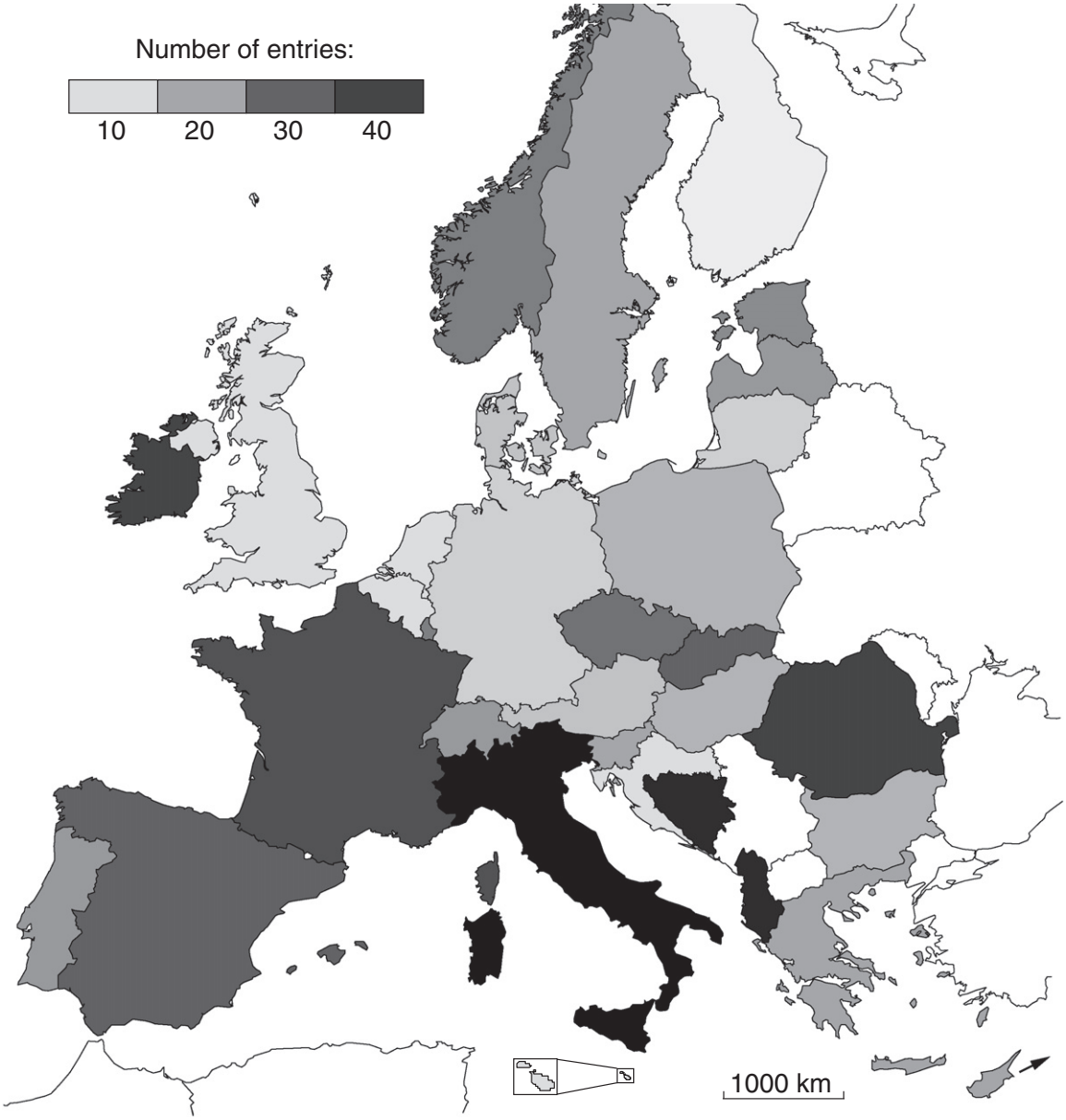

Fig. 1. Number of entries per country of the survey in Europe (631 entries in total).

For clarity, we did not distinguish between barriers and reasons for the barriers in the questionnaire and the analysis of the results, but the discussion at the end of the paper refers to both.

The following five types of data were specified in the questionnaire: streamflow, precipitation (raingauges), radar rainfall data, geospatial data (including DEM), other data (such as water quality data).

Each questionnaire had also space for the contact details of the respondents to keep track of the process, facilitate follow up procedures and to ensure the target population has been sampled adequately.

Before actually distributing it, the questionnaire was tested by submitting draft questionnaires to a representative sample of the institutions to be surveyed, represented by data providers and data users in the HYDRATE Hydrometeorological Observatories in six European countries. These data were analysed and the questionnaire was then improved to ensure that the instructions and questions were clearly understood and the results could be analysed by the planned stratifications.

Assessment of the survey method

The clarity of the questions asked by the survey was evaluated by reading through all surveys and analysing the consistency of the responses received. Apparently, the vast majority of the surveyed people correctly understood the posed questions with the exception of the one on "data quality awareness". Instead of indicating if data quality is a cause for barriers (see the letter in Appendix), most of the surveyed people reported whether they considered the data to be of good or poor quality. For this reason we do not analyse the data quality responses in this paper.

The survey consisted of write-in boxes rather than multiple choice questions because of the complexity of the questions asked. Hence, some degree of interpretation was needed. Interpretation was done by expert judgement taking all the responses into account at the same time. In order to identify responses not explicitly asked for, we counted which kind of responses were given most frequently. They are used in the "second level analysis" (see below).

The response rate, i.e., the percentage of questionnaires completed from the total sample queried, was quite high: 32 out of 35 countries responded with a total of 127 questionnaires and 631 entries completed. The number of entries differs between the countries (Fig. 1), which may be due both to the local variation in the efficiency of the contact network and to different institutional and organisational arrangements of the hydrometeorological networks. For instance, Italy has the highest number of entries, which is partly due to the large number of regional scale data providers. The average number of entries per country is 20 with a standard deviation of 10.

Analysis of the survey results

The first step of the analysis was to build a homogeneous data set from the heterogeneously filled in questionnaires. In most instances the responses were very clear. There were a few instances, were subjective choices had to be made on what we thought was the intention of the respondents in order to increase the quality of the data set. For example, when the respondents ticked the types of barrier (instead of writing in "yes" or "no") we interpreted the types not ticked as not being a barrier. However, this only affected a small fraction of the questionnaires.

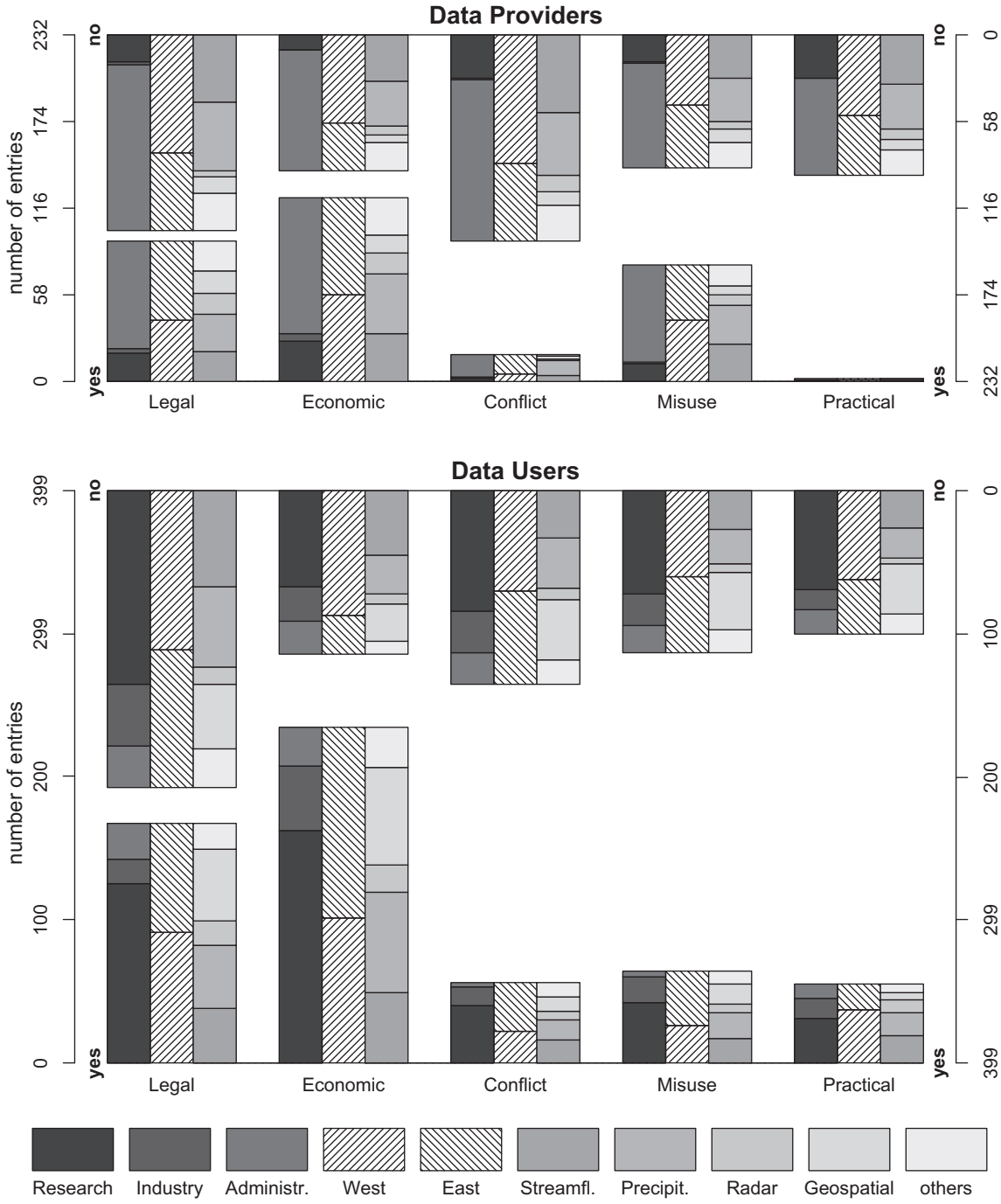

Fig. 2. Perceived barriers stratified by data providers and data users, type of institution (research, industry and administration), country (West and East Europe) and type of data (streamflow, precipitation, radar, geospatial, others). The upward bars give the number of entries that indicated that the type of barrier exists ("yes"), the downward bars give the number of entries that indicated that the type of barrier does not exist ("no"). First level analysis.

In an attempt to identify patterns of data policy and data exchange perceptions across Europe, the entries were stratified in the following way:

- data providers and data users,
- type of institution (research, industry and administration),
- country (West and East Europe),
- type of data (streamflow, precipitation, radar, geospatial, others).

Fig. 2 summarises the survey results ("first level analysis", see below) in terms of the above mentioned stratifications. Classification by country was done according to former political spheres of influence into West and East in order to understand differences due to economic systems and science culture. The following countries were considered to pertain to the West: Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom. The following countries were considered to pertain to the East: Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia.

The significance of the perceived barriers was tested in two ways. At first we tested whether there exists a significant *majority* that thinks that a particular barrier exists (or does not exist), by comparing the number of "yes" entries with the number of "no" entries (Fig. 3). We then tested whether the number of "yes" entries is significantly larger than a threshold percentage for which one may assume that the problem should be considered at a European scale (Fig. 4). The threshold was chosen as 15%.

The binomial test was used, which is a test of the statistical significance of deviations from a theoretically expected distribution of observations into two categories (Siegel, 1956). Suppose that, for the question "Do you perceive economic barriers to data exchange to exist?", we received 89 answers of which 56 were "yes" and 33 "no". The hypothesis to be tested is whether the proportion of "yes" is significantly higher than in the null hypothesis of equal probability of receiving a "yes" or a "no" answer. The binomial distribution B(89, 1/2) gives the probability of finding exactly 56 "yes" in a sample of 89 if the true probability of a "yes" on each response is 1/2. We then evaluate the probability of finding exactly 57, exactly 58, and so on up to 89, and add all these probabilities together. In this way, we obtain the probability of obtaining the observed result (56 "yes") or more (>56 "yes") in case the null

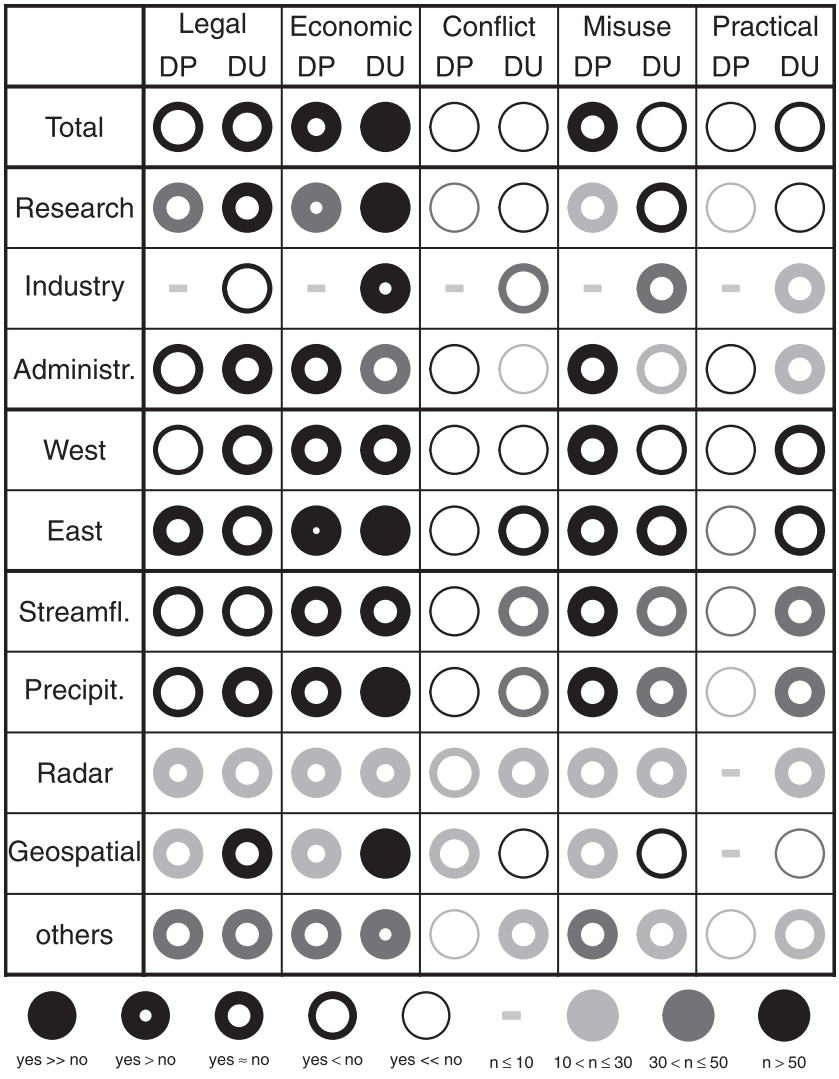

Fig. 3. Is it a significant majority that thinks (or does not think) that a particular barrier exists? The significance is counted on the basis of entries (yes and no) stratified by data providers and data users, type of institution (research, industry and administration), country (West and East Europe) and type of data (streamflow, precipitation, radar, geospatial, others). The symbol indicates the significance and grey shades indicate the number of entries per class.

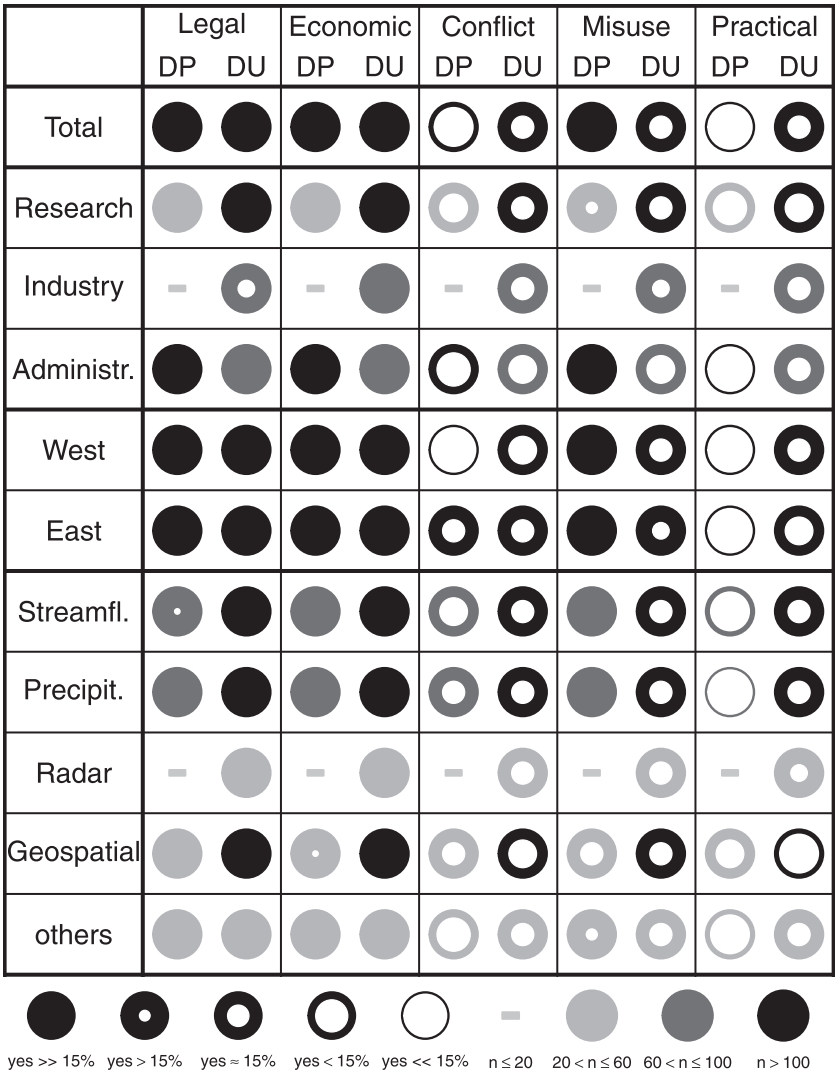

Fig. 4. Is a particular barrier named in significantly more (or less) than 15% of the entries? The significance is counted on the basis of entries (yes and not yes) stratified by data providers and data users, type of institution (research, industry and administration), country (West and East Europe) and type of data (streamflow, precipitation, radar, geospatial, others). The symbol indicates the significance and grey shades indicate the number of entries per class.

hypothesis is true. In this example, the result is $P = 0.00959$, which means we would have a >99% chance of being right to reject the null hypothesis (one-tailed test). We interpret this result by saying that a significant majority of the interviewed people are concerned about economic barriers (significant at the 1% level). The same test was used to test if the proportion of "no" is significantly higher than 1/2.

In the example above all the respondents say either yes or no while in reality there is always a number of no responses. In this majority analysis we do, however, only focus on the "yes" and "no", as it is difficult to assign the meaning of the "no response". One reason for "no response" could be that respondents do not perceive a particular barrier to exist and failed to state "no" but, alternatively, they might be hesitant to admit that it exists.

For the second analysis (Fig. 4) we assume there is no problem with a barrier if less than 15% of the respondents state that the barrier exists while there is a problem if more than 15% of the respondents state that it exists. In this case we compare the number of "yes" to the "non-yes" (i.e., "no" + "no response"). Again we apply the binomial test against the null hypothesis of having exactly 15% of "yes" responses. Fifteen percent is considered here an (arbitrary) action level where a policy change would be required.

Results

Characteristics of respondents

Out of the 127 questionnaires received, 61 were filled in by data providers and 66 were filled in by data users. Table 1a shows the number of entries in the questionnaires received, stratified by data providers and data users, type of institution and country. Although the number of questionnaires from data providers and data users is similar (61 and 66, respectively), the data users have a larger number of entries, with 232 entries for data providers and 399 for data users. This would be expected as data providers tend to provide only few types of data (i.e. only those they manage), while one single data user uses many types of data, e.g., streamflow, precipitation and geospatial data. The statistics in Table 1a also show that the largest percentage of data provider entries is from administration (82%), whereas the largest percentage of data user entries is from research (66%). The relative number of entries is similar in the West and East, both for data providers and data users.

Streamflow and precipitation are the data types that have most frequently been referred to in the questionnaires (Table 1b). There is not much difference between data providers and data users in

Table 1a
Number of entries in the questionnaires received, stratified by data providers and data users, type of institution (research, industry and administration) and country (West and East Europe). The entries appear in 61 questionnaires received from Data providers and 66 questionnaires from Data users.

	Total number of entries	Research	Industry	Administration	West	East
Data providers	232 (100%)	37 (16%)	5 (2%)	190 (82%)	124 (53%)	108 (47%)
Data users	399 (100%)	263 (66%)	74 (19%)	62 (15%)	217 (54%)	182 (46%)

Table 1b
Number of entries in the questionnaires received, stratified by data providers and data users and type of data (streamflow, precipitation, radar, geospatial and other data).

	Total number of entries	Streamflow	Precipitation	Radar	Geospatial	Other
Data providers	232 (100%)	65 (28%)	73 (31%)	20 (9%)	29 (12%)	45 (19%)
Data users	399 (100%)	108 (27%)	104 (26%)	34 (9%)	100 (25%)	47 (12%)

Table 2a
Number and percentage of entries in which legal barriers are perceived to exist (or not to exist) by data users and data providers.

	Yes	No	No response	Total
Data providers	94 (41%)	131 (56%)	7 (3%)	232 (100%)
Data users	167 (42%)	207 (52%)	25 (6%)	399 (100%)
Total	261 (41%)	338 (53%)	32 (6%)	631 (100%)

terms of the percentage the data types are mentioned. For radar there are only a small number of entries because we classified only raw radar into this category. The composite rainfall products (involving radar and raingauge data) mentioned in the questionnaires were not considered in the analysis because they are products rather than data. Geospatial data are mentioned much more frequently by the data users than by the data providers. This may be related to the selection of the data providers in the survey. Often, geospatial data such as digital terrain models are collected and managed by surveying offices while most of the data providers contacted were hydrometeorological offices. The "other" class of data types includes air temperature data, wind speed, groundwater levels, water quality data and sewer system data.

The results are discussed below by the type of barrier, starting with legal barriers and proceeding with economic reasons, conflict of interest, misuse awareness and practical problems. Two types of analyses of the results are performed here. The *first level analysis* means that we analyse the frequencies of "yes" and "no" for every type of barrier/reason, stratified by the type of the institution who provided the information, by country (grouped in West or East Europe), or by the data type. Fig. 2 summarises the results of the survey in terms of the total number of "yes" and "no" responses to the existence of a particular barrier. The shading of the bars relates to the stratification of the respondents. The *second level analysis* means that we analyse the frequencies of "yes" stratified by what type of use (research, commercial) the respondent thinks the barrier applies and what are the specifics of the barrier.

Legal restrictions

For legal barriers the first level analysis in Table 2a suggests that the number of "no" is slightly larger than the number of "yes" for both data providers and data users. This means that there is no unique perception of the respondents. The difference between yes and no is barely significant for the data providers (more "no" than "yes" is significant at the 1% level but not at the 0.1% level, Fig. 3) while it is not significant for the data users. This means that there is not a large difference between providers and users, suggesting that personal biases are not important in this case.

The majority of data providers of the administration does not think that legal barriers exist. This is a significant result at the 1% level. The data users of the administration give a more balanced response, although they are few. Data users from the industry do not consider legal barriers a problem. There were only five entries from data providers from the industry, so significances are not shown in Fig. 3. Research institutions are mostly data users and they give mixed responses on the existence of legal barriers.

Fig. 3 also indicates that there exist differences between West and East European countries. Data providers from the Western countries do not think that legal barriers exist while data providers from the Eastern countries give mixed results, about half the entries, suggesting they do exist. The responses for the data users are similar in the East and the West without a preference. Fig. 3 also shows the significance of the responses considering the different types of data. For streamflow and precipitation data, data users are more concerned than data providers of the existence of legal restrictions.

The second level analysis in Table 2b suggests that the respondents recognise that legal barriers exist for commercial purposes (52% of "yes") while they rarely exist for research purposes (3% of "yes"). More than half of the entries (58%) with legal barriers suggest that a licence agreement needs to be signed while 8% of these entries suggest that the data cannot be provided at all for any purpose. For example, in some instances, digital terrain models cannot be provided for military reasons. Although the data users state more often than data providers that legal barriers exist (Table 2a), the data providers state more often than data users that licence agreements are needed (Table 2b). This suggests that the data providers are more aware of the type of legal barrier.

Economic reasons

Economic barriers are considered very important by the respondents. The first level analysis in Table 3a and Fig. 2 suggests that the majority of the data users think that economic barriers to the free exchange of the data exist (significant at the 0.1% level, see Fig. 3). Data providers, in contrast, give mixed results. This would have been expected as the data users need to bear the costs. Out of the types of institutions, the research institutions give the most significant response of the existence of economic barriers, followed by industry and administration (Fig. 3). Also, the research institutions that provide data agree on this point, although the response is less significant. For the East European countries this seems to be a more serious problem than for the West European countries, as both data providers and data users are concerned (significant at the 0.1% level).

The economic constraints seem to apply to all data types (streamflow, precipitation, radar, geospatial, others). Also, the perception of data users that there are more often economic constraints than what the data providers suggest applies to all data types. This is particularly the case for precipitation and geospatial data as the data users state that precipitation and geospatial data

Table 2b
Second level analysis of legal barriers perceived by data users and data providers: number of entries and percentage of "yes" in which additional information on the barrier is provided.

	Yes (applies to research purposes)	Yes (applies to commercial purposes)	Licence agreement needed for research and commercial purposes	Data cannot be provided at all for any purpose	Total of yes
Data providers	2 (2%)	39 (41%)	65 (69%)	6 (6%)	94
Data users	6 (4%)	96 (58%)	87 (52%)	15 (9%)	167
Total	8 (3%)	135 (52%)	152 (58%)	21 (8%)	261

Table 3a
Number and percentage of entries in which economic barriers are perceived to exist (or not to exist) by data users and data providers.

	Yes	No	No response	Total
Data providers	123 (53%)	91 (39%)	18 (8%)	232 (100%)
Data users	234 (59%)	118 (30%)	47 (11%)	399 (100%)
Total	357 (56%)	209 (33%)	65 (11%)	631 (100%)

are expensive (the majority of "yes" is significant at the 0.1% level) (Fig. 3).

It is now interesting to explore whether the differences between the data types is due to responses from the West or the East. One would expect different patterns, as in most Western countries the hydrological services and meteorological services are separate entities, while in most Eastern countries there are joint hydrometeorological services. Fig. 5 shows the responses on perceived economic barriers stratified by country (West and East Europe) and type of data. The top panels give the number of entries that indicated that economic barriers exist ("yes"), the bottom panels give the number of entries that indicated that economic barriers do not exist ("no"). This is an additional stratification (West–East) of the first level analysis of Fig. 2. Fig. 5 indicates that in the West there is indeed a major difference between responses on streamflow and precipitation, while in the East this is not the case. In the West, access to precipitation seems to be a major problem

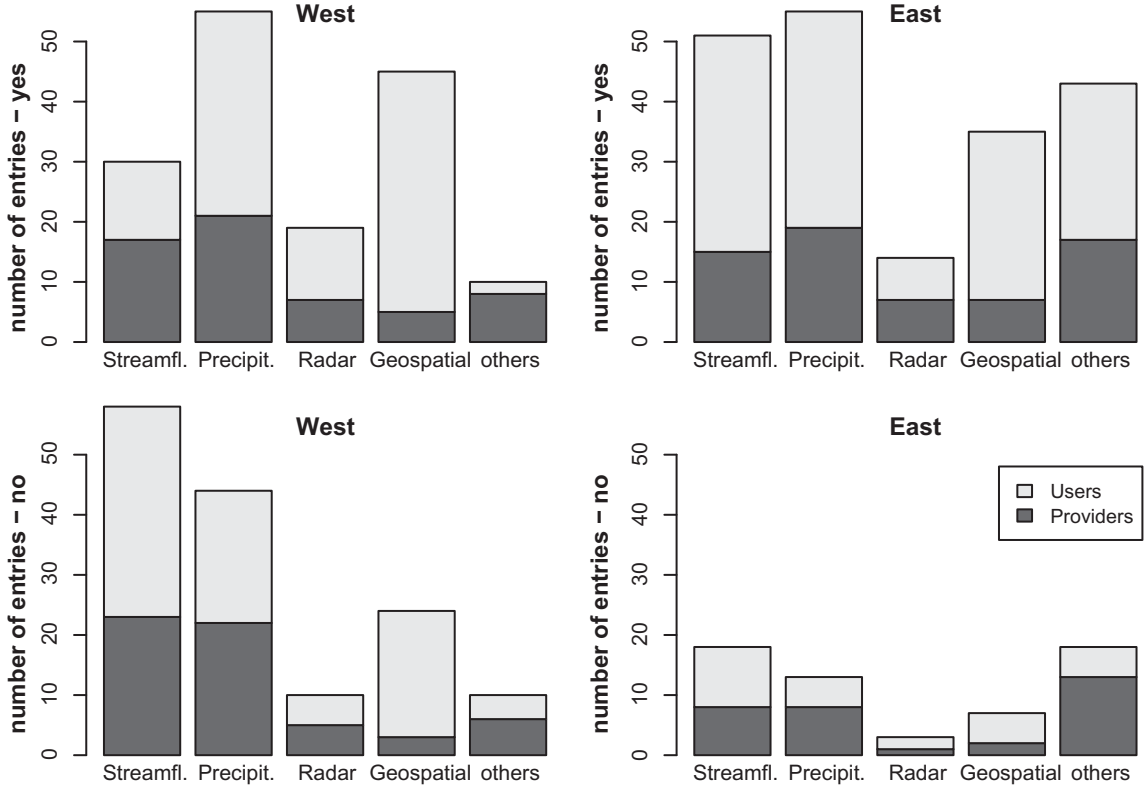

Fig. 5. Perceived economic barriers stratified by data providers and data users, country (West and East Europe) and type of data (streamflow, precipitation, radar, geospatial, others). The top panels give the number of entries that indicated that economic barriers exist ("yes"), the bottom panels give the number of entries that indicated that economic barriers do not exist ("no"). Additional stratification (West–East) of the first level analysis.

Table 3b
Second level analysis of economic barriers perceived by data users and data providers: number of entries and percentage of "yes" in which additional information on the barrier is provided.

	Free or cheap for research purposes	Expensive for research purposes	Free or cheap for commercial purposes	Expensive for commercial purposes	Total of yes
Data providers	58 (47%)	23 (19%)	38 (31%)	33 (27%)	123
Data users	88 (38%)	47 (20%)	29 (12%)	74 (32%)	234
Total	146 (41%)	70 (20%)	67 (19%)	107 (30%)	357

due to economic reasons, while in the East both precipitation and streamflow are a problem. The difference in the West is due to the data users; the data providers do not seem to acknowledge that there is a difference between precipitation and streamflow. It is also interesting that there is a larger number of responses on geospatial data in the West than in the East for the data users, so geospatial data seem to be a bigger issue in the West. In contrast, there is a larger number of responses on "other" data (including meteo/climatic data) in the East than in the West. This may be related to the fact that hydrometeorological services deal with both hydrologic and meteo/climatic data. Apparently, hydrology and meteorology are more strongly linked in the East than in the West. Of course, the are a number of Western countries (such as Sweden) where hydrometeorological services exist, so this finding does not apply at the scale of individual countries.

We now analysed the frequencies of "yes" stratified by the type of use (research or commercial) the respondents suggest the barrier applies, and what are the specifics of the economic barrier (free or cheap) (Table 3b). In 41% of the entries in which economic barriers are perceived, the respondents state that the data are free or cheap for research purposes, while only in 20% of the cases the data are considered expensive for research purposes (Table 3b). Data providers state more often than data users that the data are cheap or free for research purposes but the difference is small (47% vs. 38% of "yes"). Regarding the cost of data for commercial purposes, 30% of the respondents state that they are expensive while 19% state that they are cheap or free. Here, the responses of data providers and data users differ: the overall result that data are considered expensive for commercial purposes is due to the responses of the data users rather than the data providers.

Conflict of interest

Another reason for barriers to data exchange are conflicts of interest between data providers and data users. Table 4a suggests that the majority of data providers and data users that gave an answer does not consider the conflict of interest to be a barrier. However, there is a large difference between the responses of the data providers and the data users. Fifty-nine percent of data providers say that conflicts of interest are no reasons for barriers while only 34% of the data users share this view. In contrast, only 8% of data providers say that conflicts of interest are a reason for barriers, while 14% of the data users share this view. It is interesting that 33% of the data providers and 52% of the data users did not give a response, which could contain some implicit "no". The larger percentage of "no response" of data users may imply that the possibility of conflicts of interest is considered less of an issue by them.

Fig. 3 shows that, whatever the stratification, the "no" response is always very significant, more for the data providers than for the data users. The exception are the data users of the industry, for which the "no" responses to conflict of interest are significant at the 1% level but not at the 0.1% level. This may be related to the commercial perspective of businesses who, unlike data users from research and administration, are likely to sell their own products based on the data which also the data providers could sell.

Table 4b gives specifics on the types of conflict of interest that are perceived (second level analysis). When conflicts of interest are perceived to exist, data providers always state this is because they sell their own products based on the data they own, so sharing the data would compromise their commercial interests (100%). For example, Meteorological Services collect data and sell forecast products. Most responses of the data users (70%) give the same reasons, but in eight cases they suggest that data could be used as information by competitors of the providers. For example, data of hydropower companies are often not freely available because of competition and other concerns.

Misuse awareness

Similarly to the conflict of interest, misuse awareness may be a reason for barriers to data exchange. In this case, the data providers are much more concerned about misuse (by the data users) than are the data users themselves (Fig. 2 and Table 5a), not only because there is a larger number of yes, but also a larger number of responses. Table 5a shows that 34% of data providers perceive misuse as an issue and 38% of them do not, which is a mixed response (see Fig. 2). Data users, instead, significantly state that misuse is not a reason for barriers (29% of "no" vs. 17% of "yes"). Fig. 3 shows that the difference between data providers and data users is particularly evident in Western Europe. Data users in the East are more aware of the misuse potential than data users in the West. Also in this case, the percentage of "no response" is large and mainly due to data users (see Table 5a). This could imply that the "no" expressed by data users is even stronger than the 29% explicitly accounted for.

No particular differences exist in the perception for different types of data, for which mixed responses are provided, except in the case of geospatial data, for which data users state that misuse is not an issue (at the 0.1% level of significance, Fig. 3). Perhaps this is because they are more expensive and/or more strongly regulated by legal agreements than the other data types (Fig. 2).

Table 5b contains the second level analysis, i.e., what specific data misuses are perceived to be important. In most of the cases, data redistribution is the issue (for 86% of the data providers and 69% of the data users). Criticism and data reprocessing are only indicated in a few instances, the former by data users and the latter by data providers.

Practical problems

Although the side letter of the questionnaire referred to practical problems such as lack of resources or staff to supply data (i.e. potential reasons for barriers), the responses were explicit about

Table 4a
Number and percentage of entries in which conflict of interest is perceived (or not perceived) as a reason for barrier by data users and data providers.

	Yes	No	No response	Total
Data providers	18 (8%)	138 (59%)	76 (33%)	232 (100%)
Data users	56 (14%)	135 (34%)	208 (52%)	399 (100%)
Total	74 (12%)	273 (43%)	284 (45%)	631 (100%)

Table 4b
Second level analysis on the perception of conflict of interest as a reason for barriers by data users and data providers: number of entries and percentage of "yes" in which additional information on the reason for barriers is provided.

	Provider sells own products	Information for competitors	Total of yes
Data providers	18 (100%)	–	18
Data users	39 (70%)	8 (14%)	56
Total	57 (77%)	8 (11%)	74

Table 5a
Number and percentage of entries in which misuse is perceived (or not perceived) as a reason for barrier by data users and data providers.

	Yes	No	No response	Total
Data providers	78 (34%)	89 (38%)	65 (28%)	232 (100%)
Data users	64 (17%)	113 (29%)	222 (54%)	399 (100%)
Total	142 (23%)	202 (32%)	287 (45%)	631 (100%)

Table 5b
Second level analysis on the perception of misuse as a reason of barriers by data users and data providers: number of entries and percentage of "yes" in which additional information on the reason for barriers is provided.

	Redistribution	Criticism	Data reprocessing	Total of yes
Data providers	67 (86%)	–	5 (6%)	78
Data users	44 (69%)	2 (3%)	–	64
Total	111 (78%)	2 (1%)	5 (4%)	142

practical barriers such as difficulties with getting access to the data (e.g. undue delays), and generic problems of accessibility and usability of the data made available (e.g. when data are provided on paper instead of electronically). The first level analysis in Table 6a and Fig. 2 strongly suggest that data providers do not consider practical barriers to exist. Only 1% of the data providers say that practical barriers exist, while 40% of the providers say they do not. In contrast, data users do suggest that practical barriers exist although the "no" responses are still the majority. There is a large percentage of "no responses" for both data providers and data users. One reason could be that they do not perceive a practical barrier to exist and failed to state "no" but, alternatively, they might be hesitant to admit that the practical barriers exist, particularly the data providers.

There is no regulatory, official framework that would control these barriers. Rather they may occur on a personal basis, so one would expect large differences in the perceptions which is actually the case. Surprisingly, data users from research institutions do not consider practical barriers to exist (69 "no", 29 "yes"), while for administration and industry there is no preference. There are hardly any West–East differences in the perception of the existence of practical barriers. In both cases, data providers strongly suggest that no practical barriers exist, while the results of the data users are more mixed.

In a second level analysis, the practical barriers were classified into three categories on the basis of the entries provided by the respondents: data accessibility problems (data provided on the web but inconvenient for the users such as a very large number of files, so downloading them is very time consuming, or data provided on paper rather than in electronic format, data provided as graphics rather than as numbers); delivery time (data provided later than agreed leading to undue delays in projects); usability problems (unclear units, unavailability of meta data such as rating curves; change of rain gauge locations). The results are reported in Table 6b. Since only two data providers responded that practical barriers exist the overall result is due to the data users. In many cases (47%) the perceived barrier is data accessibility. The problems of delivery time and data usability are less frequent. However, it should be noted that the classification shown in Table 6b was not given in the questionnaires. This may have discouraged the respondents to mention usability problems, for example. One would expect that data quality issues occur more often than stated by the respondents. This is supported by the fact that the data providers never mention these issues while many data users give this information without being asked explicitly.

Table 6a
Number and percentage of entries in which practical barriers are perceived to exist (or not to exist) by data users and data providers.

	Yes	No	No response	Total
Data providers	2 (1%)	94 (40%)	136 (59%)	232 (100%)
Data users	55 (14%)	100 (25%)	244 (61%)	399 (100%)
Total	57 (9%)	194 (31%)	380 (60%)	631 (100%)

Table 6b
Second level analysis of practical barriers perceived by data users and data providers: number of entries and percentage of "yes" in which additional information on the barrier is provided.

	Data accessibility	Delivery time	Data usability	Total of yes
Data providers	–	1 (50%)	–	2
Data users	27 (49%)	14 (25%)	14 (25%)	55
Total	27 (47%)	15 (26%)	14 (25%)	57

Discussion

Types of barriers – perceptions of data providers and data users

Although, in the questionnaires, we did not distinguish between barriers and reasons for the barriers, it may be useful to discuss them separately. We suggest that there are three types of barriers: legal, economic and practical barriers. The reasons for the barriers are discussed in the next section.

The most frequent barriers identified by the respondents are economic barriers (named in 357 out of 631 entries), followed by legal barriers (named in 261 entries), and practical barriers (named in 57 entries). The only type of barrier where a significant majority of a group (data users, data providers) think they exist are the economic barriers and the group are the data users. The majority of data providers still think economic barriers exist but this majority is not significant. The more widely perceived concern by data users would have been expected as the data users need to bear the costs of data to be acquired. However, there is still a large proportion of data providers that are concerned about economic barriers. It is certainly much more than the 15% action level chosen in this study (Fig. 4). Quite clearly, if action is to be taken to encourage the free exchange of data in Europe, the economic barriers need to be addressed first and foremost. The economic concerns of data users, apparently, are the costs, while the economic concerns of the data providers are really the reason for charging for the data and thus setting up a barrier to free data exchange.

More specifically, from the second level analysis (what type of institution the respondent thinks the barrier applies to, Table 3b) one can see that clearly there are major differences in the data policy of data providers towards the different uses of the data. There are also major differences between the perceptions of data providers and data users. For example, the finding that data are considered expensive for commercial purposes is due to the responses of the data users rather than the data providers. In other words, data users say more often than data providers that the data are expensive which, again, has to do with the fact that the users have to bear the costs of buying the data.

Regarding the other types of barriers, the data providers are somewhat less concerned about legal barriers than are the data users. The difference is likely due to perceptions, as the institutions providing the data do not say they apply legal restrictions, while those receiving the data are concerned that legal barriers exist. In some cases the same institution filled in questionnaires in its capacities as data provider and data user and even then the responses differed, suggesting that the perceptions may differ even within the same institution. Although legal barriers are not considered to exist by the majority of the respondents in any of the groups analysed here, in almost all the groups they significantly exceed the 15% action threshold assumed here. This means the legal barriers are perceived as a real barrier by a sizably part of the groups involved. The perception on practical barriers (such as undue delays, and problems of data accessibility and usability) is very different. Data providers do not consider practical barriers to exist. In contrast, a number of data users (not significantly different from 15%) do think they exist (see Fig. 4).

The differences between the perceptions of data providers and data users depend strongly on the type of barrier. The differences are smallest for legal barriers, followed by the economic barriers and are largest for the practical barriers (Tables 2a, 3a, 6a, Figs. 2–4). This seems to be related to the degree to which a regulatory framework controls these types of barriers. The legal issues are clearly controlled, the economic to some extent, and for the case of practical problems there is no official framework that would control them. Rather they may occur on a personal basis, so one would expect large differences in the perceptions.

Reasons for barriers

We consider three reasons for the existence of barriers in this study: economic, conflict of interest, and misuse awareness. The economic considerations mentioned in the questionnaires cannot only be considered a type of barrier but also a reason for the barriers to exist. In fact, economic concerns appear as a barrier to data users and are a reason for data providers to apply charges. The latter, in particular applies to those data providers that have to cover some of the expenses related to the data by earning an income from selling them. If there is to be a free exchange of data the data providers need an incentive to share the data by having a budget that would cover their costs of data collection, management and retrieval.

In the survey, two more reasons have been analysed: conflict of interest and misuse awareness. The majority of the data providers and data users do not consider the conflict of interest to be a barrier. However, conflict of interest is considered to exist by about 15% of the data users in most of the groups analysed (Table 4a, Fig. 4). For data providers this conflict of interest, generally, is not considered an issue. It may well be that data providers do not fully acknowledge the existence of this type of barrier. Data providers are much more concerned about misuse, significantly more than 15% (Fig. 4). Obviously, this is because data providers sell their own products based on the data they own, so sharing the data would compromise their commercial interests. For perceived misuse, in most of the cases, data redistribution is considered to be responsible.

Stratification of results (type of institution, country, type of data)

Out of the types of institutions, the research institutions give the most significant response of the existence of economic barriers, followed by industry and administration (Figs. 2 and 3). Budget seems to be a major concern at the research institutions which apparently have experienced major difficulties with paying for the data they use in their research. Also, the research institutions that provide data agree on this point, although the response is less significant. In contrast, from the second level analysis (Table 3b) it seems that all types of institutions state that data for research purposes are more often free or cheap than expensive. The overall result that data are considered expensive for commercial purposes, not surprisingly, is due to the responses of the data users rather than the data providers. Legal barriers exist for commercial purposes, while they rarely exist for research purposes. Interestingly, there is not much difference between data providers and data users, so the limitations and opportunities of data use for research and commercial purposes seem to be well understood. Data users at research institutions are less concerned about practical problems than are those at industry and administration. They may be better fit to surpass the practical problems of accessing the data. For example, professors have their former students working in the agency of the data providers which may open up the doors for streamlining the data transfer.

For the East European countries the economic reasons seem to be a more serious problem than for the West European countries, as both data providers and data users are concerned. While a full analysis of the political situation in a historic context in the East European countries is beyond the scope of this paper, it seems to be clear that the different perceptions are related to the change of the political system in 1989. There was a transition in many of the countries classified as East European, where a centralised data holding strategy gave way to a market oriented use of the data held by some of the institutions. Making money from the data legacy, the so called cost recovery model (Weiss, 2002), has apparently become one of the policies while the data users' economic means for purchasing the data have not kept up with the pace of the transition to the market economy. The majority of data providers from the Western countries do not think that legal barriers exist, while data providers from the Eastern countries give mixed results suggesting that legal barriers may be an issue. The latter may be related to recent changes in the legal systems which may make data providers feel uncomfortable with. While for legal and economic barriers there are some differences between West and East, this is not the case for practical problems. The lack of difference between Western and Eastern countries about practical problems suggests that, while the economic and legal situations differ significantly across Europe, informal networking may not. Even if the majority of the respondents state that there is no conflict of interest problem, the responses from the East European countries suggest that data providers do consider it more of a problem than their colleagues in the Western countries from which the numbers of yes is significantly less than 15% (Fig. 4).

As would be expected there are significant differences of the perceived barriers between different data types. Most importantly, a significant majority of the data users state that economic barriers exist for precipitation and geospatial data (Fig. 3), while this is not the case for other types of data. The perceived economic barriers for precipitation and runoff, for example, are similar in the East European countries but they differ in the West European countries. One would expect different patterns, as in most Western countries the hydrological services and meteorological services are separate entities, while in most Eastern countries there are joint hydrometeorological services. In the West, access to precipitation seems to be a major problem due to economic reasons, while in the East both precipitation and streamflow are a problem. There seems to be a major difference in the data policies between meteorological offices and hydrological offices. Meteorological offices more strongly rely on selling the data. Similarly there are major differences in the data policies between surveying offices that handle geospatial data and hydrological offices and again, the former tend to sell the data more expensively or more often than the hydrological offices.

Conclusions and implications for data policy

The main barriers to the free exchange of hydrometeorological data across Europe identified in this survey are of economic nature. The economic concerns of data users are the costs of the data, those of the data providers are to acquire an income from selling the data to offset the expenses for collecting, managing and retrieving the data. From a data user perspective, the costs of the data, apparently, often is inconsistent with what seems to be justified within their budgets, in particular if research institutions are concerned. To encourage the free exchange of data to a more efficient use of available resources and the rich data legacy that exists in Europe, certain regulations at the EU level would be useful for sharing the data, particularly in the context of the Water Framework Directive and the Flood Directive. From a data provider perspective,

what is needed is an incentive to freely share their data by providing a budget to the respective services that would cover their costs of data collection, management and retrieval. If there is to be a free exchange of data, adequate funding of the services is clearly a cornerstone.

There are major differences between West and East European countries. It is clear that, if the economic barriers are to be addressed in a European policy context, the East European situation requires particular attention. Not only data pricing policies, but also the recognition of the potential future economic value of hydrological information seems to create an effective block to transfer information. The information is sometimes withheld in the expectation that, in an indistinct future, the service may have the capacity to fully analyse the data and transfer only customized information and not the data.

Out of the data types surveyed, the costs of precipitation and geospatial data seems to be the most serious problem. Precipitation, as compared to other types of data, is particularly perceived as a problem in the West where the meteorological offices are separated from the hydrological offices. So, again, particular attention needs to be devoted to the issue of providing precipitation data in the West. In the East, however, all data types seem to be associated with economic constraints.

In a drive for the commercialization of services, costs emerge as an effective barrier to access hydrological data. This has significant impacts both inside Europe, and outside Europe, since European data policies are often used as a template for developing data policies in developing countries, where this type of barriers may inhibit research on vital hydrological topics. This shows the urgent need of pan-European studies on the economics of the services of data collection, archiving and transferring (including economics of the hydrological information per se). If economy may be singled out as an effective barrier to hydrological data exchange, it is clear that both data provider and data users (as well as policy makers) should know more about the nature and costs of current data flows, and about the relevant costs. Different options for funding the provision of hydrological services and for charging for the information provided should be described and evaluated.

Transfer of hydrological information should be embedded in an information feedback cycle which provides benefits for both the data providers and the data users. Governments and hydrological services should be informed about the benefits of shared information and about the value-added benefit which can be derived from this. The interests of data providers and data users must be recognized and adequately embedded in a data exchange policy. The protocols for the transfer of information must be known to the public and be transparent to all participants. Feedback may be a significant motivator to provide information. Examples are the provision of feedback mechanisms about the use of transferred information and the obtained results. This feedback cycle may reduce the asymmetry between the perceptions of data users and data providers on the barriers to data exchange, and hence to encourage a more efficient access to the rich data legacy that exists in Europe.

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Appendix. Survey letter

Identification and analysis of barriers preventing free exchange of hydrometeorological data across Europe

Rationale

Exchange of hydrometeorological data across institutions is crucial for better capabilities of flash flood analysis at the European scale for a number of reasons:

- Flash floods affect all of Europe and the forcings often develop at the continental scale.
- Flash floods are locally rare events and tend to be poorly observed, so pooling events across Europe is essential for obtaining a sizable data base for process studies.

Different types of barriers may affect data exchange across Europe, both within countries and among countries. In the context of the European project HYDRATE, potential data exchange barriers in European countries are examined in this survey by polling data providers and data users separately.

Filling in the tables

Please fill in the table (either data user or data provider) in this document. Indicate the name and type of your institution (industry, administration, research). Consider the types of data listed in the rows (streamflow, precipitation, radar, geospatial data including DEM and other types, e.g. sewer system network) and specify details in the column on *data type* (time resolution (hourly, daily), space resolution, whether they are maximum annual values, mean monthly values etc. as applicable).

Barriers to free data exchange listed in the columns of the table are:

- *Legal restrictions* related to the circulation of data that are accessible only to some (often governmental or institutional) organisations, and not to external users (such as stakeholders). For example, in some countries, geospatial data are considered as restricted information for military reasons.
- *Economic reasons* related to the pricing/costs of hydrometeorological data (often very expensive) and/or the charges applied for the time required to make the data accessible (often a minor expense). This reason also relates to the costs of collecting the data.
- *Conflict of interest* may arise when data providers develop and sell their own value-added products from the raw data they obtain, so there is a disincentive for them to provide data to potential competitors.
- *Misuse awareness* when data providers fear economic misuse of data by users (e.g. users reselling the data), or technical misuse (e.g. users to develop their own (inappropriate) design values) and prefer to provide end products (e.g. T year floods) to the users.
- *Data quality awareness* when data providers are concerned about public scrutiny over their own products (e.g. inconsistent rating curves).
- *Practical problems* when data providers lack resources and/or staff to supply the data.
- *Other,* e.g., privacy issues of person-related information and potential political issues.

Please indicate also the name/type of the data provider or the type of data users in the last column (see Tables A.1 and A.2).

Use of survey results

All the survey results will be analysed and presented in an aggregated/anonymous way. No names will be associated with

Table A.1
Survey form to be filled in by data users.

Name of **data user**	Industry	Administration	Research

	Data type	Legal restrictions	Economic reasons	Conflict of interests	Misuse awareness	Data quality awareness	Practical problems	Other	Name of data provider
Stream flow									
Precipitation									
Radar									
Geo-spatial data									
Other									

Table A.2
Survey form to be filled in by data providers.

Name of **data provider**	Industry	Administration	Research

	Data type	Legal restrictions	Economic reasons	Conflict of interests	Misuse awareness	Data quality awareness	Practical problems	Other	Type of data users
Stream flow									
Precipitation									
Radar									
Geo-spatial data									
Other									

the results. One of the potential outcomes of the survey may be to recommend to the European Commission a better financial basis for data collection at the European scale. Another potential outcome is more clarity about cost-effectiveness and legal/perceptual problems of data exchange across Europe.

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