Research Article

Policy Analytics-Insights from Pakistan and India Water Policies

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Abstract | The role of water in economic output, job creation, household sustenance, and industrial growth depends on the kind of water systems and policies a country develops and implements. Due to its value and importance in all aspects of life, water is a highly political issue. The purpose of this study is to explore the water policies of Pakistan (2017) and India (2012) through quantitative analysis of textual data. The text mining of these water policies enables to analyze the massive amounts of information quickly, making connections and surface important links between entities. The results show that Pakistan's National Water Policy, 2017 is more comprehensive as compared to India's National Water Policy, 2012. India's water policy distinctively prioritizes industrial growth at the cost of its agriculture sector; and while it mentions inter-regional and inter-state disputes in sharing of water as detrimental, the issue is not tackled at length in the document. Pakistan's policy, on the other hand, is more multi-sectoral in terms of focus on irrigation, agriculture, climate change, research and development, inland navigation and the importance of the Indus River. Pakistan's water policy does, however, fall short in terms of lack of attention given to water sensitive urban designs, risk management against natural hazards and mapping of water-sector development in line with the Sustainable Development Goals; and trade in water-intensive crops. Both governments can learn from each other and update their respective water policies in the light of these quantitative findings.

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Introduction

Three little atoms, the simple bond of two hydrogen atoms with one oxygen, is all it took to create life on earth. A growing population, urbanisation, industrialisation and changes in consumption and production patterns, are resulting in a rapidly increasing demand for this simple combination of atoms. While nearly 70% of the world is covered with water, less than one % is readily available for human consumption. According to the European Environment Agency (2012), sustainable water management requires knowledge, robust data, and indicators that can show the linkage between water management, social and economic benefits, and ecosystem services. Despite technological advancements providing clean water, more than one billion people worldwide are still suffering from inadequate access to clean water (Swyngedouw, 2007). Water plays a vital role in health, agriculture, food production, econom-

ic growth, energy, natural environment and politics. The governance of how water is used, who uses it and how much is used, is consequently very complex.

Even with the world's largest glaciers, Pakistan (and India) is among the world's 36 most water-stressed countries. One of the consequences of rapid population growth has been significant decline in per capita water availability - from 5,260 cubic meter in 1951 to 908 cubic meter in 2017. As per International Standards, a country having annual per-capita water availability of < 1700m^3 is categorized as 'water stressed'. With per capita available water of 1545 m^3 India is also a water stressed country. According to the Food and Agriculture Organization (FAO), Pakistan's water pressure on total renewable water resources has reached an alarming 74%. The country's water storage capacity is only 10% of its annual water flows, enough for approximately 30-36 days only.

Despite these worrying facts, the development and implementation of a national water policy faced delays for more than a decade due to provincial reservations. The first-ever National Water Policy of Pakistan, after a decade of wrangling and consultations, was finally approved on 24 April 2018. It has been hailed as a 'milestone', 'groundbreaking' and 'historic' document.

The Indus water treaty was an agreement signed between Pakistan and India fifty years ago. The agreement was signed to avoid the water conflict between neighboring countries. Due to lack of realistic anticipation while signing the water treaty, Pakistan is still facing certain problems which are impacting its economics and social fabric. Salman *et al*. (2018) argued that clean water is very important for the livelihood of nations and climate change is restricting clean water supply, through prolong droughts in certain areas of Pakistan. It is quite plausible to think and realize that water governance from now becomes an important issue to consider for the basic necessities and secure ecosystem of Pakistan. On one side, Indian and Pakistan are faced with a situation of transboundary water conflict and on the other hand climate change is intensifying the water scarcity.

As compared to Pakistan, India has three different versions of a water policy. The National Water Policy (NWP) of India was first enunciated in 1987. Thereafter, the NWP was revised in 2002 and 2012. The revisions were linked to issues such as rapid urbanisation, population growth, growing water insecurity, problems in water governance, wide temporal and spatial variations in water availability and access to safe drinking water.

The water resource allocation problem is interdisciplinary nature. This water allocation must be as integrated with hydrology, agronomic, economic, and institutional components (Mukherjee, 1996). Exhaustive literature is available on water issues from different perspectives and fields. For instance, the impact of varying water availability on the environment, irrigation and the value of irrigated agricultural production (Kirby *et al*., 2015).

The policy-making process involves some form of verbal or written communication available in electronic format, which requires new tools and methods to analyse large amounts of textual data. Text mining is an emerging field that encompasses new research methodologies and software tools (*e.g.* R, Python, Orange) that are being used by companies, governments and academia.

There are several subjective analysis and reviews about water policies. For instance, according to Pandit and Biswas (2019), India's water policy is no more than a 'feel good' document. However, no quantitative analysis of water policies is available in literature. To fill this gap, this study is an attempt to use an emerging field of text analytics to estimate policy preferences from officially documented policies of Pakistan and India. The analysis of the text come up with the important topics discussed in both polices. Section 2 of this paper provides the data and methodology. Section 3 discusses the empirical results followed by a conclusion and recommendations.

Materials and Methods

Data

For this study, water policies of India and Pakistan have been reviewed. The National Water Policy (2018) of Pakistan is available with the Ministry of Water Resources (2018). The most updated, National Water Policy (2012) of India is available with the Ministry of Water Resources, River Development & Ganga Rejuvenation (2012).

Methodology

Text analytics is a powerful and evolving tool of de-

riving high-quality information for harnessing the power of unstructured textual data, like government documents, social media, books, newspapers, emails, *etc*. By using the automated algorithms, the objective is to discover new knowledge by revealing the hidden patterns and summarise the main themes and compare them. Text analytics helps to identify the facts, correlations and assertions in a consistent, unbiased manner. The processed data can be integrated into databases and used for both descriptive and predictive analytics.

Table 1: *Distribution of term frequencies - frequency of frequencies table of Pakistan's Water Policy.*

Freq.	Freq. of Freq.	Freq.	Freq. of Freq.	Freq.	Freq. of Freq.
1	1362	29	2	68	1
2	453	30	5	72	1
3	229	31	1	74	1
4	132	32	3	76	1
5	106	33	5	77	1
6	79	34	2	80	1
7	65	35	3	84	1
8	50	37	2	92	1
9	31	38	4	100	1
10	39	39	1	109	1
11	25	40	1	110	1
12	24	41	3	119	1
13	15	42	1	126	2
14	21	43	5	138	1
15	12	44	3	144	1
16	14	46	3	150	1
17	12	47	2	159	1
18	13	48	1	164	1
19	9	50	1	176	1
20	4	51	1	177	1
21	9	52	2	191	1
22	3	54	3	210	1
23	9	55	2	249	1
24	5	56	2	288	1
25	7	59	3	341	1
26	4	60	2	765	1
27	7	61	2		
28	4	65	1		

Freq., Frequency.

There is growing and significant applications of text mining in sentiment analysis (Aslam *et al*., 2020; Li and Wu, 2010), systematic reviews (Ananiadou *et al*., 2009), computing science (Liu and Wong, 2009) and social sciences (Wiedemann and Wiedemann, 2016). In last few years, text mining has also entered the fields of economics and finance (Bollen *et al*., 2011; Levenberg *et al*., 2014; Sun *et al*., 2016). Likewise, there are examples of applications of text mining in the field of anthropology, communication, political science, psychology, education, and sociology (Acerbi *et al*., 2013; Sun *et al*., 2016; Lazard *et al*., 2015; Grimmer and Stewart, 2013; Kallus, 2014; Colley and Neal, 2012; Evison, 2012; Mische, 2014).

Data pre-processing and data cleaning

The following data processing and data cleaning tasks were performed: (i) Conversation of the scanned documents into text files (only in case of Pakistan); (ii) Corpus building: The primary task was to build a corpus of both policy documents. The study uses R package 'tm' for the transformations to prepare the document for text analysis. The primary package for text mining, tm (Feinerer, Hornik and Meyer; 2015), provides the Text Mining Framework for this study; (iii) Conversion the entire document to lower case and removing punctuation; (iv) Removing stopwords (stopwords are common words found in a language. To increase computational performance, 174 words like and, or, in, is, for, were removed), Numbers and extra whitespace; (v) Stemming (Stemming uses an algorithm that removes common word endings for English words, such as 'es', 'ed' and 's'); and (vi) Creating a Document Term Matrix.

Results and Discussion

Pakistan's National Water Policy, 2018

In raw form, Pakistan's water policy consists of 52 pages, 1,445 paragraphs, 1,1949 words and 79,153 characters. The clean data after text processing, we are left with 1,609 unique terms and 64,740 characters. In Table 1, distribution of term frequencies is reported.

There are 719 unique words in the policy document, 288 words appear twice, and 142 words appear thrice. Collectively, 1300 terms have a frequency of five or less. There are 309 words with frequency greater than five; and 144 words with a frequency greater than 10. Likewise, 49 terms appear more than 20 times; and 24 words have a minimum frequency of 30. In most frequent terms, there are only 2 having frequency greater than 100; 15 terms have frequency greater

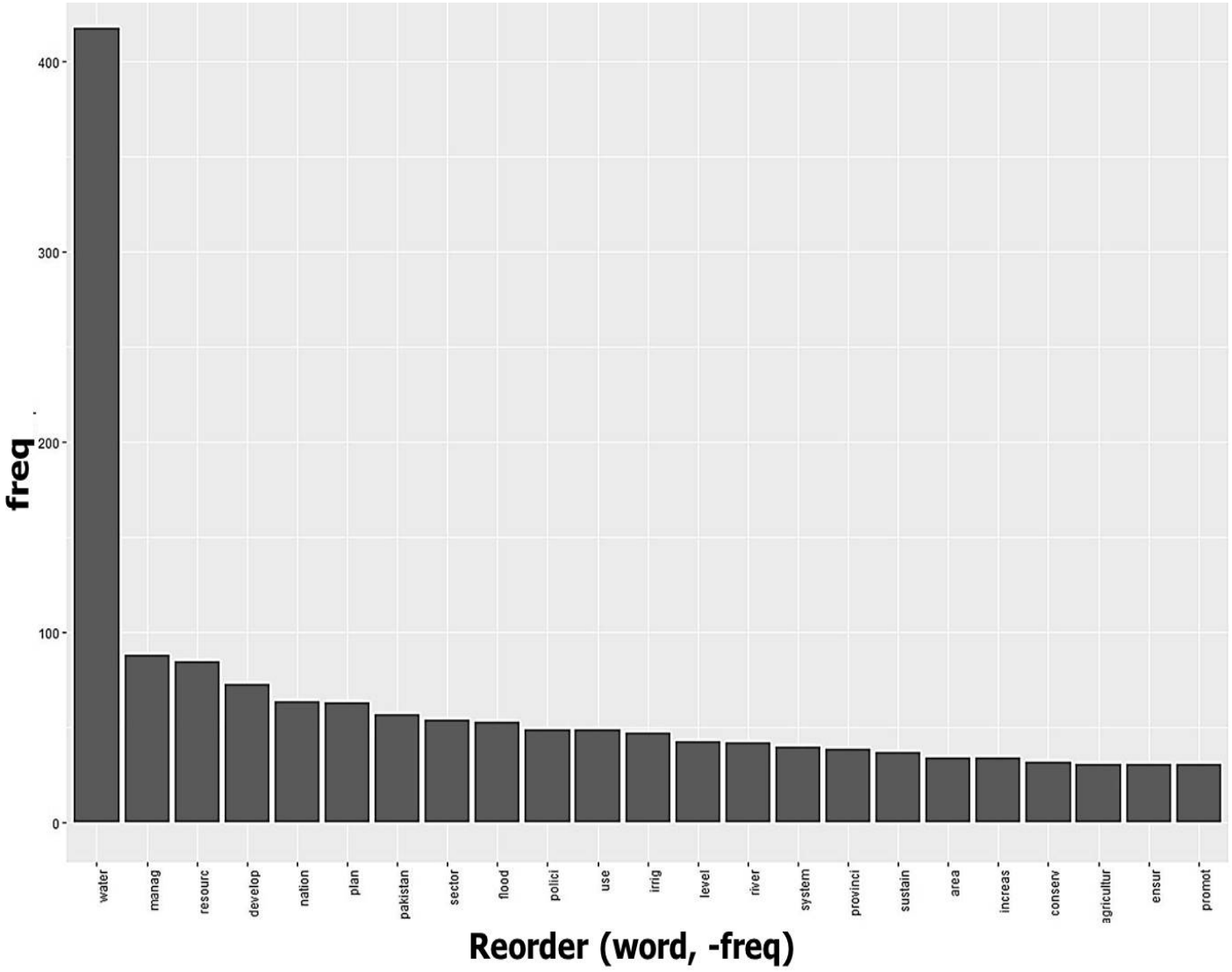

Figure 1: *Frequency plot – Pakistan's' Water Policy.*

than 40; and 10 terms have frequency greater than 50. The most common terms in Pakistan's water policy are presented in Figure 1. The most common terms include water (N=418), shall (N=168), manage (N=88), resources (N=85).

Figure 2 shows the lexical dispersion of the most frequent terms in Pakistan's National Water Policy (2018). Each strip represents an instance of a word, and each row represents the entire text. The graph shows the occurrence and location of these common words in the policy document. It is depicted that the word 'water' is dispersed smoothly from the beginning till the end of the document. Contrarily, the term 'flood' mostly appears in the middle of the document, and is not discussed at the end of the policy document. The terms 'manage', 'resource' and 'develop' are located with gaps in almost all sections. The word 'Pakistan' and 'nation' collectively appear 121 times in the document and appear mostly at start and end of the policy.

India's National Water Policy, 2012

The Indian water policy is precise as compared to Pakistan. In raw form, it consists of 17 pages and 30,917 characters only. After text transformation, there are 25,012 characters only. The details are reported in Table 2 which shows the distribution of term frequencies.

As compared to Pakistan (n=1609) unique terms, India's water policy consists of 856 unique terms. There is only one word 'water' with frequency greater than 100 (n=211), no word falls between the frequency of 50 and 100; and only six words having minimum frequency of 25. 21 words appear have minimum frequency of 15; and 41 words appeared ten times or more.

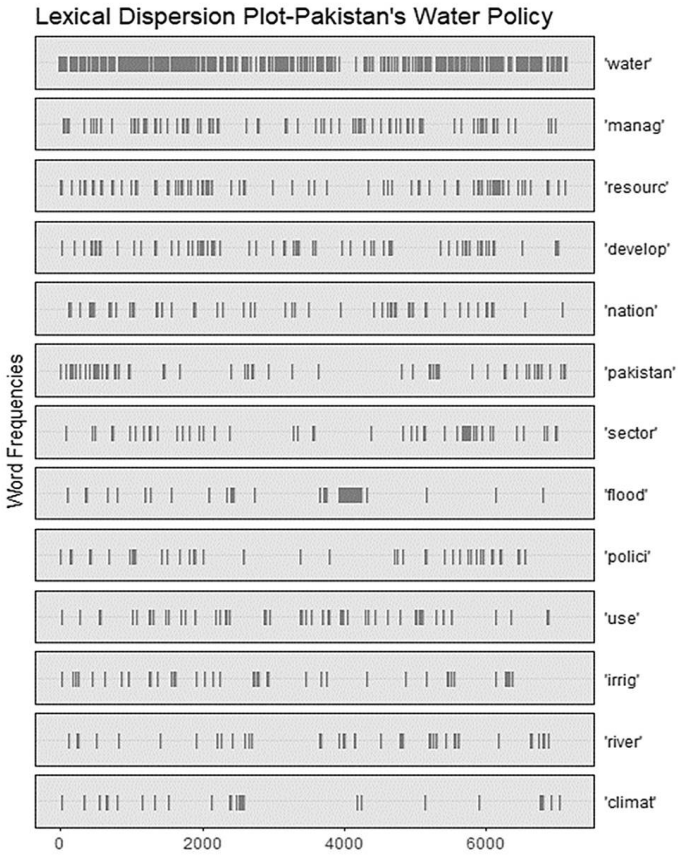

Figure 2: *Lexical dispersion plot-Pakistan water policy.*

Table 2: *Distribution of term frequencies - frequency of frequencies table of India's Water Policy.*

Frequency	Frequency of Frequency	Frequency	Frequency of Frequency
1	402	15	1
2	175	16	2
3	79	17	1
4	45	18	3
5	34	19	1
6	31	21	3
7	20	22	2
8	13	24	2
9	16	28	1
10	8	32	1
11	6	40	1
12	1	43	1
13	3	49	1
14	2	211	1

Comparatively, there are 403 terms which appear only once in the document and 175 words repeats only once. Figure 3 shows the most frequent terms in India's water policy: 'water' (N=211), 'need' (N=1609), 'resource' (N=43), 'use' (N=40), 'manage' (N=32), 'plan'

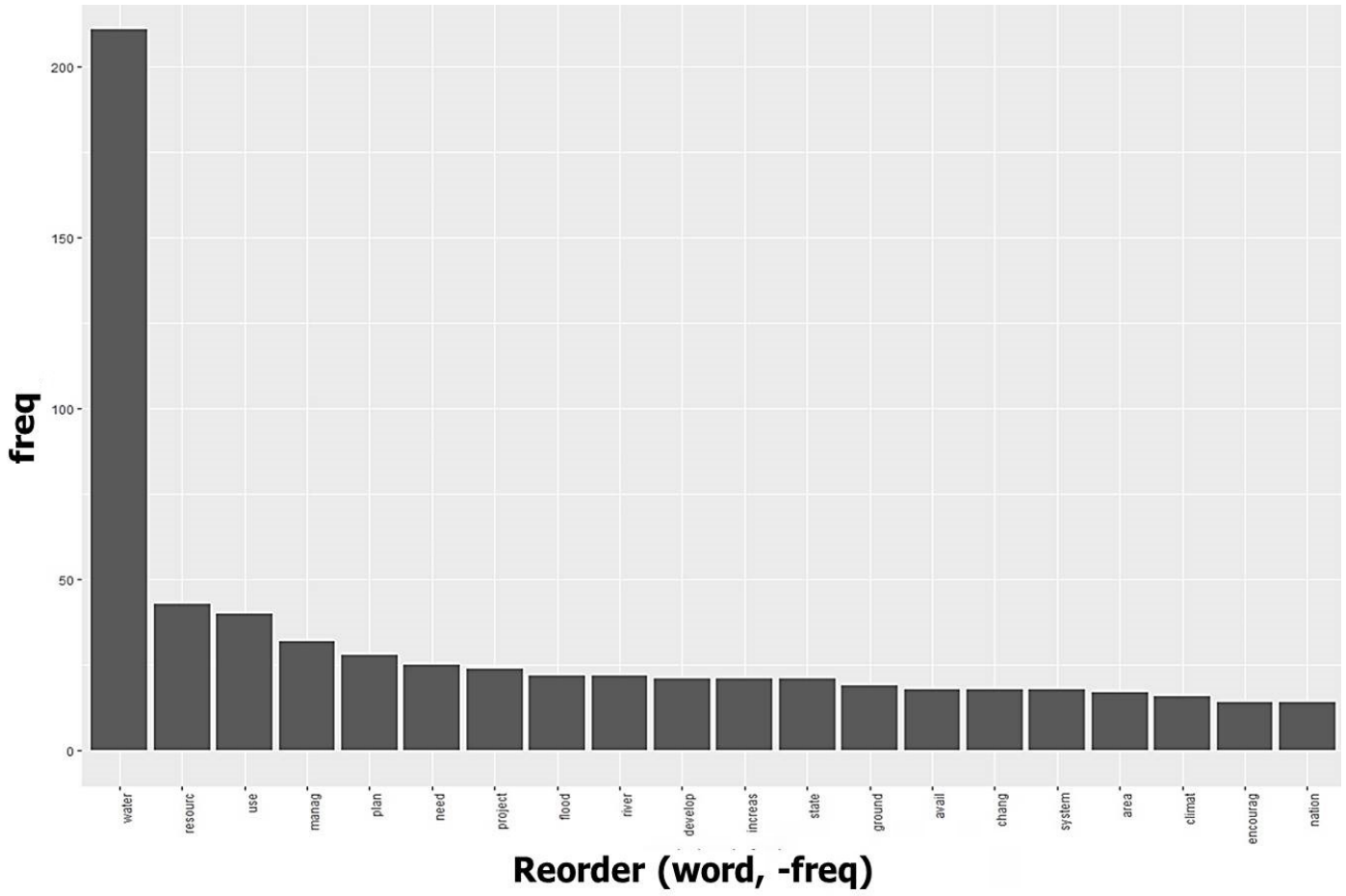

Figure 3: *Frequency plot – India's' Water Policy.*

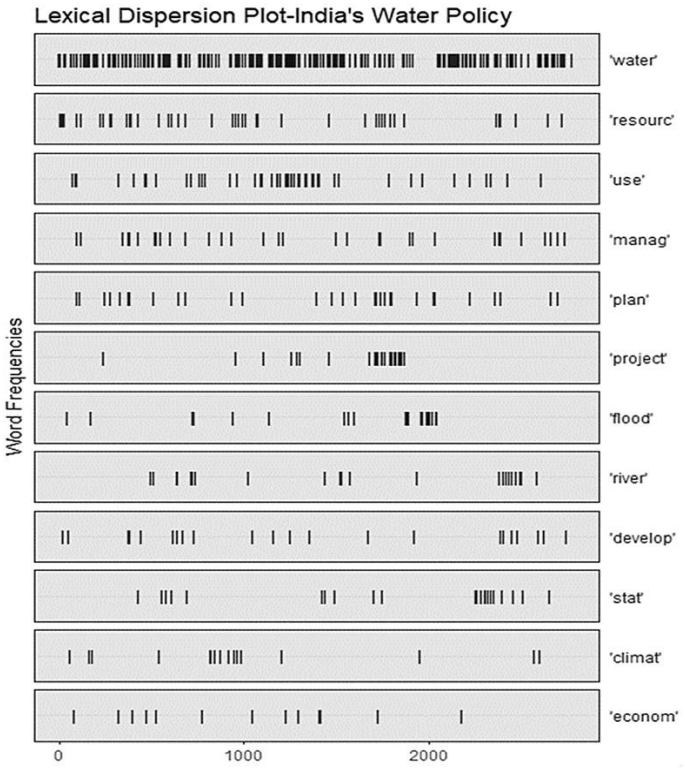

Figure 4: *Lexical dispersion plot–Pakistan Water Policy.*

(N=28), 'project' (N=24), 'flood' (N=22), 'river' (N=22), 'develop' (N=21), 'increase' (N=21) and 'state' (N=21).

Figure 4 shows the lexicon dispersion of India's water policy. The plot shows the dispersion of the top ten common words. Although the term 'water' appears almost half as less than Pakistan's policy, the dispersion is almost similar which means the term is dispersed in all sections. A similar pattern can be observed for 'resources' in the document. The terms 'planning', 'development', 'use', and 'management' are also dispersed in all sections of the water policy. Contrarily, India's water policy discusses 'rivers' which are absent in Pakistan's policy.

Comparison between the two policies

To compare the water policies of both countries, the study uses 'similarity', 'comparison', 'word in common' and 'word cloud' graphics. The distinct results can be seen with comparative word clouds of both policies in Figure 5. The colors and fonts show the more frequent

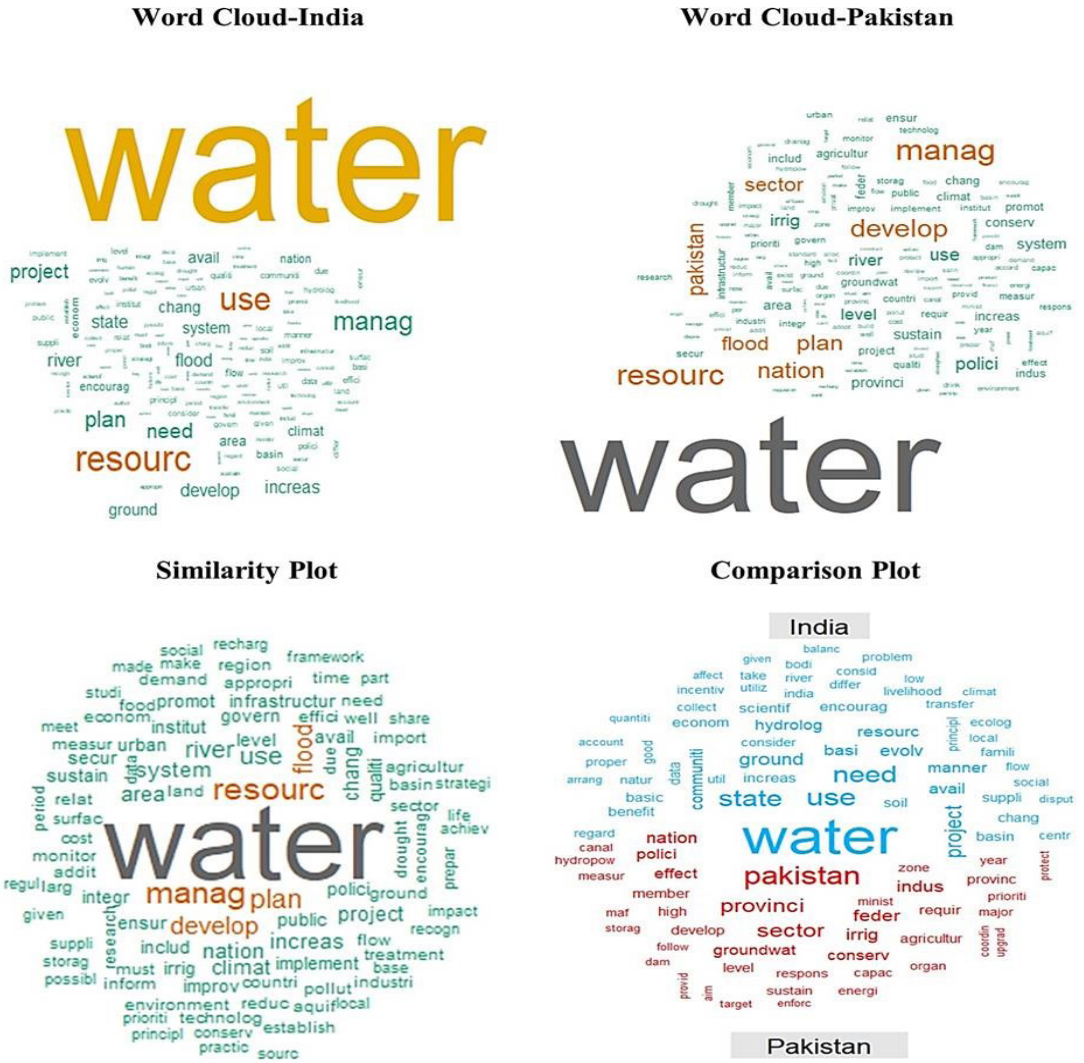

Figure 5: *Word clouds, similarity, comparison plot - India and Pakistan Water Policy.*

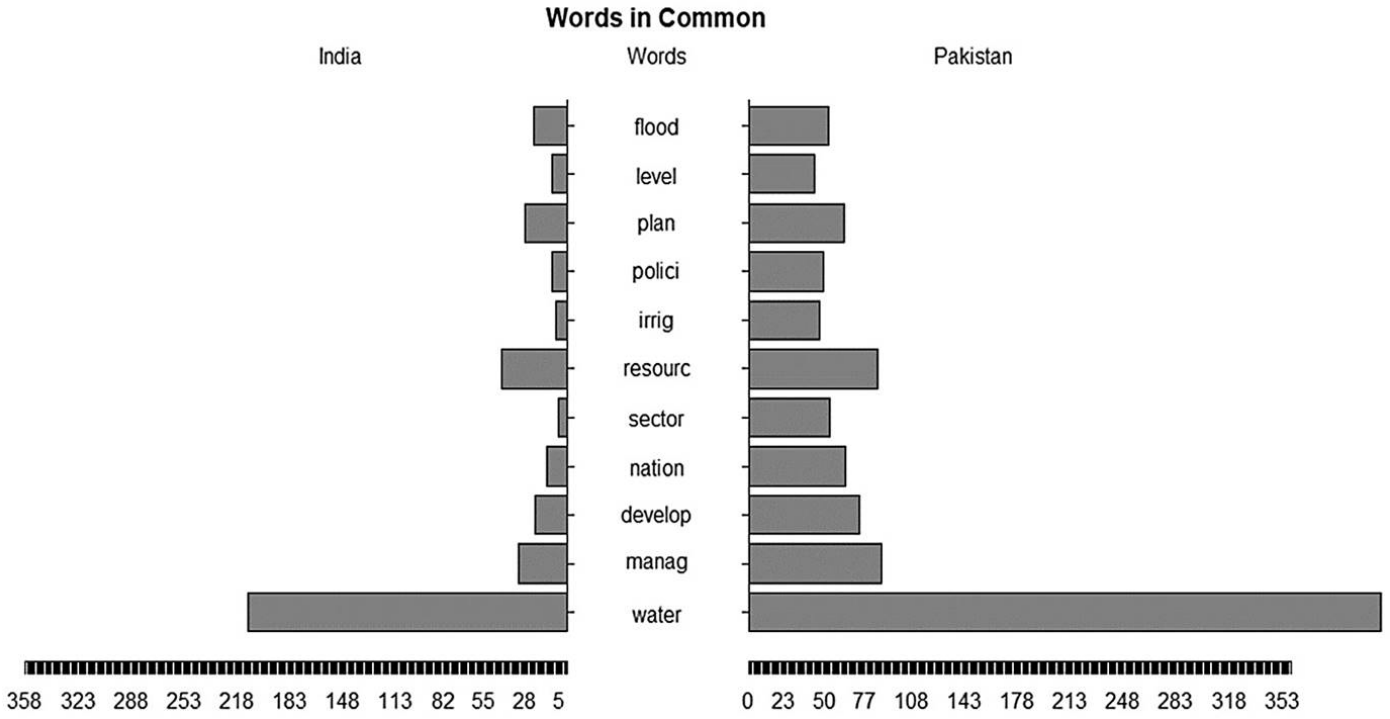

Figure 6: *Words in Common between water policies of Pakistan and India.*

agendas of the document. This comparison of both policies is depicted in Figure 5. The similarity plot shows the most common words in their water policies. The similarity plot also shows the similarities between these two policies. The colors and fonts show the more frequent agendas of the both. Larger font size shows more frequent terms in the document. It is clear from the similarity plot that both countries have commonly focused on water, resources, floods, management, planning and development. On the right side, the comparison plot shows the most frequent terms of India's policies in blue font; while the red font at the bottom shows the most frequent terms in Pakistan's water policy.

In addition to a comparison plot, Figure 6 shows the frequency of words in common between the two water policies. The results show that both policies focus on water, planning, development, irrigation systems, agriculture sector, nation and policy design. Figure 6 shows that that the most common word in both policies is understandably 'water'. However, the bar length shows that Pakistan's Water Policy has more focused on water as compared to India. The second most frequent common focus is management of water resources followed by development. Both policies focus on the agricultural sector and irrigation system, but Pakistan is more interested in floods and agriculture as compared to India.

One salient feature in India's water policy is focus on real-time data collection and database management. The second important difference is the focus on economic value of water by treating water as economic good and evaluating its wastage and inefficient usage. The third feature is India's stress on new water resources projects, project funding, and maintenance of old projects, timely completion and execution in *pari-passu* manner. Last but not the least, India's water policy especially provides institutional level importance to the river basin to resolve inter-State, inter-regional disputes to improve water use efficiencies.

As compared to India, Pakistan's water policy is unique in terms of its focus on policies, irrigation, agriculture, and the importance of the Indus River. Having one of the largest irrigation networks in the world, the policy especially focuses on irrigation. The term appears 47 times in the policy document with importance given to maintenance of the irrigation system, low irrigation efficiency, drainage as part of irrigation planning, its indispensable importance for Pakistan's agriculture and the provincial government's role. In case of Pakistan, the special focus on irrigation is absence of alternative water sources and 26% of the total domestic vegetable is cultivated using wastewater (Hussain and Hanjra, 2003).

Under the 18th Constitutional Amendment, water

distribution for agriculture, domestic and industrial falls under provincial management. Despite the economic importance of water and calls for increased infrastructure investment on projects like the Bhasha Dam, the Centre has delegated a lot of responsibilities and powers to provincial governments. The second most unique priority of Pakistan's water policy is the agriculture sector. With respect to agriculture, the policy focuses mainly on the drainage improvement, threats to coastal lands, food security, agriculture productivity, hydropower facilities and role of universities and departments.

Third, Pakistan's policy contains the word 'Indus' 29 times. This is because of the importance of the Indus Waters Treaty (IWT) and international water laws, monsoon waters flow into the Indus River, its dependence on climate change and faster melting of the glaciers, Indus Basin Replacement works (especially dams) and diversion of canal water. Another salient feature of Pakistan's water policy is the provincial autonomy. The policy focuses on provincial master plans, Provincial Irrigation and Drainage Authority (PIDA), Provincial Water Authority (PWA), formulation of policies related to water pricing, drinking water, water quality, provincial agriculture, repair and maintenance and development expenditures. Although Indian and Pakistani commissioners conduct regular meetings, peaceful management of their Indus River system remains largely unexamined (Zawahri, 2009). The government of Pakistan particularity focus on the Indus water after that India violated the Indus Waters Treaty by initiating the construction of Baglehar Dam in 1999 and its threats to block rivers to Pakistan (Qureshi, 2017).

Although both countries mention climate, however, Pakistan's water policy is significant (N=30) given its review of issues like intensification of floods; erratic, monsoon rains; and frequent droughts outlined as major concerns for the country. The policy emphasizes on the serious consequences of climate change on water resources, food security, water flow in the Indus system, and increasing/frequent intensity of floods. Extreme weather and monsoon rains and mitigation against the impact of climate change through storage are also topics that are tackled.

Conclusions and Recommendations

This study compares the water policies of Pakistan and India using text analytics. As compared to India, Pakistan's water policy is more comprehensive and addresses important multi-sectoral issues and concerns. Both policies focus on water resources management, development, irrigation systems and their national interest. In comparison, Pakistan's policy highlights areas linked to the agriculture sector, provincial autonomy, Indus Waters Treaty and the country's irrigation system. While the Indian policy focuses more on water and its impact on the economy, database management, basin management, ground water level, and importance and funding of water-related projects. India's water policy is contradictory in terms of water management and allocation. On the one hand, it is explicitly mentions that water needs to be managed as a community resource under public trust doctrine, on the other hand, the policy underlines the need to treat water as an 'economic good'. Likewise, the policy distinctively prioritizes industrial growth at the cost of its agriculture sector; and while it mentions inter-regional and inter-state disputes in sharing of water as detrimental, the issue is not tackled at length in the document. The policy calls attention to flood forecasting by using real-time data acquisition systems and models, but again offers little in terms of on-ground implementation and or the importance of transboundary data sharing. According to two of India's senior water experts: Pakistan's policy, on the other hand, is more multi-sectoral in terms of focus on irrigation, agriculture, climate change, research and development, inland navigation and the importance of the Indus River. The document offers specific targets for energy, agriculture and development of water reservoirs which will provide water during the non-monsoon period as well as help balance national emissions by encouraging hydropower and lowering the price of energy. Unlike India's policy, it recognizes the need for initiating regional mechanisms to address issues linked to transboundary waters such as hydro disasters owing to water release and stoppage at critical times. Pakistan's water policy does, however, fall short in terms of lack of attention given to water sensitive urban designs, risk management against natural hazards and mapping of water-sector development in line with the Sustainable Development Goals; and trade in water-intensive crops. From Pakistan's perspective, the country needs to build at least 13 dams equivalent to the Kalabagh Dam (UNDP 2017). It is facing a serious issue of decline in surface water flows and groundwater depletion rate, which is not a focus of the policy. Finally, the National Water Policy of

Pakistan does not address the role and importance of trade (N=0) in terms of the growth and export of water-intensive crops such as rice, cotton and sugarcane. This basic textual analysis indicates that governments of both these countries can learn from each other and update their respective water policies in the light of these quantitative findings.

From a public policy perspective, it is becoming increasingly important for policy analysts to have the skills to be able to compile and analyze unstructured data fast. An analyst should be able to 'mine' available online databases to collate a set of synopses, data, information, or policy recommendations so that s/he can have a concise policy review document done in hours rather than weeks. The government, academia and think-tanks need to start building the capacity of public officials in 'natural language text processing' and application of that programming to real datasets that reflect public policies.

Novelty Statement

Text mining enables to analyze the massive amounts of information quickly, making connections and surface important links between entities. In this paper, we applied recent text mining approaches to compare the water policies of Pakistan and India, making it different from existing literature.

Author's Contribution

Faheem Aslam developed the theoretical formalism, analysed data using R programming and wrote the manuscript. Aneel Salman conceived of the presented the idea and helped shape the research. Inayatullah Jan contributed to preparation of final version and supervised the project. Sarah Siddiq Aneel supervised the findings and took the lead in writing the manuscript. All authors discussed the results and contributed to the final manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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