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Research Paper

Improvement of Hydro-Meteorological Products and Services in Viet Nam: Situation Appraisal and Policy Recommendation Application

N. T. Thuy[2], N. D. Quang[2], D. Q. Tri[1*], B. M. Ha[2], H. P. Cuong[2], D. V. Trong[2] and H. D. Cuong[2]

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ABSTRACT

Rapidly developing tropical countries such as Viet Nam are experiencing a rapid demand for hydro-meteorological information services. Evaluation of end-users' demands is one way to inform policy development for organizations such as the Viet Nam Meteorological and Hydrological Administration so that they can provide the most relevant and useful products and services to the diverse and evolving market. An initial interview survey was conducted across 18 provinces and cities in Viet Nam between October and November 2017 to elicit information that would improve understanding of end-users' perception of the importance of hydro-meteorological information, the quality and utility of current products and services, and expectations for development of hydro-meteorological information over the near future. The results indicated that the contents of the bulletins or the speed of access on TV or the website of the National Center for Hydro-meteorological Forecasting) need to be improved to meet the needs of the wide range of users. Furthermore, the end-users will be happy to pay if information is accurate and timely. Experience from this initial survey will be used to expand the interview survey to the national scale, covering all 63 provinces and 5 centrally-controlled municipalities, and to increase the range of stakeholders' participation.

1. Introduction

In many countries, improvements in weather monitoring technology and distribution of data online have facilitated an expansion of hydro-meteorological data and information services, along with the number of users accessing the data (World Meteorological Organization, 2008). Ready access to meteorological forecasts assists agriculture, power supply, healthcare, public event management and tourism industries, among others, and is vital to emergency preparation to mitigate against weather-related natural hazards. In the United States, the economic value of meteorological data to society is estimated at up to USD 31.5 billion per year (Lazo et al., 2009). Readily available weather data and information is also vital in the context of appreciating, understanding, and researching climate change (Stocker et al., 2014).

According to Demuth et al. (2011), forecasts and warnings offered by hydro-meteorological information providers to end-users through various information sources. Moreover, the rise of the Internet and digital media, particularly social media, has dramatically changed the way people access information. Hydro- meteorological information can be accessed through various technologies, in particular from mobile devices.

[1]Sustainable Management of Natural Resources and Environment Research Group, Faculty of Environment and Labour Safety, Ton Duc Thang University, Ho Chi Minh, VIETNAM, doanquangtri@tdtu.edu.vn.
[2]Viet Nam Meteorological and Hydrological Administration, Hanoi, VIETNAM.
*Corresponding author: Ton Duc Thang University, Ho Chi Minh City, VIETNAM.
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A survey of the use of applications by Purcell (2011), conducted in the second quarter of 2011, found that weather applications ranked above social networking applications, coming second only to games applications. In October 2009, more than 1,000 weather applications were registered on the Apple App Store (Heilig, 2010). Understanding the way each information source being used will meet the needs of end-users when nowadays more and more hydro-meteorological products and services are being developed (Demuth et al, 2011; National Research Council, 2006 and 2010; Morss et al., 2008).

Demand for internet-accessible hydro-meteorological data and services has required meteorologists to understand how to provide information to the public in an unambiguous, rapid, simple and useful form. An accurate appreciation by hydro-meteorological providers of end-users' needs for hydro-meteorological information and how it is distributed through digital media and applications is critical to providing relevant and useful products and services. Users' perception of the accuracy and usefulness of forecasts from a given source of information could strongly influence whether - and how - they will continue to use that service (Lazo et al., 2009).

Planning and designing effective ways to distribute and present hydro-meteorological information requires the responsible organizations to understand end-users' demands (Zabini et al., 2015). Interview survey is the most common and accepted method used in social sciences to directly collect information from many respondents (Yuan et al., 2016). Van den Hurk et al. (2016) suggested that surveying the way currently available to hydro-meteorological services as to how information is utilized to manage extreme weather events can help improve the predictability of the impact of such events in the future.

A number of authors have used questionnaire surveys to obtain information about users' experiences, opinions and expectations of weather data services. Song et al. (2007) conducted a nationwide survey of the Chinese public to study the Public Weather Service but did not explore relationships between responses to the various survey questions. A similar information gathering exercise was undertaken for Italian end-users by Zabini et al. (2015), with the questionnaire filled out on a website hosted by the LaMMA Consortium (Consorzio LaMMA - Laboratorio di Meteorologia Modellistica Ambientale). Also in China, Yuan et al. (2016) undertook a survey to investigate people's understanding of hydro-meteorological information and how they use and value that information. In Viet Nam, Kluskens et al. (2015) undertook a small survey of 51 end-users spread over 16 provinces to gain a preliminary understanding of weather service delivery needs. While the results of these previous surveys provide general guidance about user needs, specific requirements for weather-related data and information are likely to vary by country, and perhaps even regionally within countries, or across demographic groups.

Currently, Viet Nam Meteorological and Hydrological Administration provides a number of forecast and warnings such as weather and marine services: rainfall amount, temperature, wave, etc (marine weather forecasts, now casting - 1 to 6 hours, short range forecasts - 1 to 3 days, medium range forecasts - 3 to 10 days, extended range forecasts - monthly, long range forecasts - seasonally), early warning services (storms and tropical depressions, floods), hydrological services: river water level and discharge forecasts (short range - 6 to 48 hours, medium range - 5 and 10 days, long range - 1 and 2 months, quarter, season and year). The products mostly uses simple text and tables (Kluskens et al. 2015). To help shape public weather service provision in Viet Nam, the Viet Nam Meteorological and Hydrological Administration requires characterization of hydro- meteorological data and information requirements across a spectrum of end-users.

This paper assessed the needs of end-users of hydro-meteorological products and services to help improve the relevance, quality and utility of hydro- meteorological products and services available in Viet Nam. An interview survey was conducted across 18 of the 63 provinces and 5 centrally-controlled municipalities of Viet Nam. The next section of this paper describes the survey and data analysis methodology. This is followed by an analysis of the results of the survey, covering users' perceptions of the importance of the information, opinions on the means of information dissemination, the level of satisfaction with existing services and products, and suggestions for future development of hydro- meteorological products and services. The discussion evaluates the implications of the results for the provision of hydro-meteorological data and services in Viet Nam and compares the results of the survey with those of some similar studies. The conclusion proposes policy solutions based on the findings of the survey that should lead to improvements in the provision of hydro- meteorological products and services in Viet Nam. The concluding segment also recommends expansion of the interview survey to the national scale.

2. Materials and methods

Face-to-face and mail interviews of end-users across Viet Nam were adopted to understand the needs of end-users of hydro-meteorological products and services. A preliminary list of potential survey questions and question concepts was created by building upon previous surveys and expert knowledge of the current state of data and service provision. This list was refined following review of relevant literature, in particular, Van den Hurk et al. (2016); Kluskens et al. (2015); Grover and Vriens (2016) and Onyango et al. (2014) and through internal testing. This resulted in a set of relevant questions that a wide range of end-users would be able to understand and respond to unambiguously.

A series of 20 questions was asked related to hydro-meteorological information dissemination, products and services on website, short message service, inclination to pay for products and services, and suggestions for improvement. Most of the questions were of the yes-no or multiple-choice form. The opportunity to provide more detailed information was provided through open-ended questions such as “Assuming you had the influence to make changes, what kind of improvements in hydro-meteorological information would you recommend?”

Areas known traditionally as disaster-prone were targeted for survey. However, in recent years natural disasters have occurred unpredictably in Viet Nam, such as a typhoon landing in the South Central Coast and severe drought in the Central Highlands. For this reason, the questionnaire was administered across provinces representing a range of geographical areas, including some not traditionally considered disaster-prone. This heightens the potential to gain insights of end-users’ perception of natural disasters and their plans for natural disaster prevention and preparedness in the future.

The interview survey was conducted from October 25 to November 3, 2017 across 18 provinces and cities in Viet Nam (**Fig. 1**). Face-to-face interviews were implemented in Hai Phong, Bac Giang, Phu Tho, Son La, Ha Noi, Thanh Hoa, Nghe An, Ha Tinh, Khanh Hoa and Lam Dong. Mailed surveys were used in Dak Nong, Dak Lak, Kon Tum, Gia Lai, Ho Chi Minh City, Can Tho, Dong Thap, Tra Vinh. The staff from the Regional Centers for Hydro-meteorological Forecasting and Provincial Centers for Hydro-meteorological Forecasting facilitated contacts with heads of villages near their working places and residence so that the research team could plan easier or actively send the questionnaire via emails.

The face-to-face interviews were conducted using a consistent protocol that involved the interviewer reading the questions to the interviewees. Responses were captured directly on the survey form. An interview lasted around 15 minutes averagely, but took longer when interviewees elaborated on the open questions. The mailed surveys were returned within one or two weeks of mailing. The total number of interviews was 1110, but 59 of these were rejected due to missing data, giving a total of 1041 valid sets of observations. SPSS statistical software was employed to analyze the data.

3. Results

In this paper, the relationships among age, occupation and interviewees’ replies were not analyzed. The focus was on the information they have provided to improve hydro-meteorological products and services.

3.1 Importance of hydro-meteorological information and the preferred mode of information dissemination

According to collated interview results, 74% of interviewees affirmed that hydro-meteorological information has an impact on their daily lives. A minority of 26% answered in the negative. Seventy-two percent monitored hydro-meteorological information on a daily basis, 26% only checked during dangerous weather conditions and the remaining 2% checked irregularly.

Television, radio and internet were the three common sources which are used to get weather information. Respondents normally check all three sources when natural disasters occur (45%). Besides that, television only or television and internet were also preferred (**Fig. 2**). To rate which was/were the most valuable sources after using three information sources above, the high percentage of respondents chose television with 35% (**Fig. 3,** and **Fig. 4**).

The majority of the respondents affirmed that hydro-meteorological information has influenced their lives, which is why most people update the information on a daily basis. This finding is consistent with that of Zabini et al. (2015).

Television was the most valuable information source than Internet and radio during disasters, although end-users preferred to use all three channels during disasters. This was also demonstrated in a study of Hoa (2016) in a survey in the Central Viet Nam provinces. The study indicated that of television, newspapers and radio, television was superior in conveying hydro- meteorological forecasts for the population in Central Viet Nam (85.67% of television watchers). A similar conclusion on the preference for television as an information source in Viet Nam was drawn by Kluskens et al. (2015).

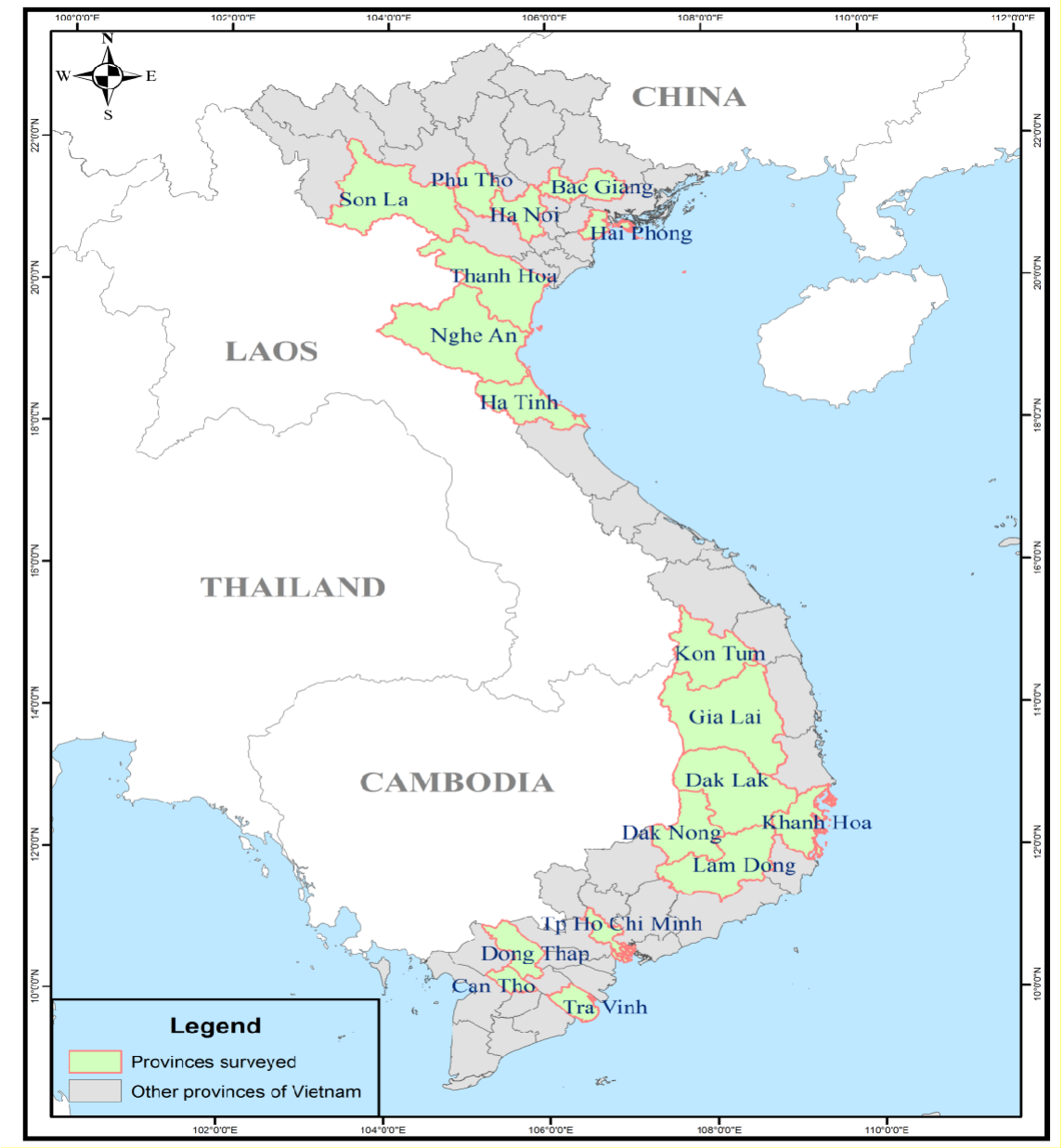

Fig. 1. Provinces where surveys were undertaken.

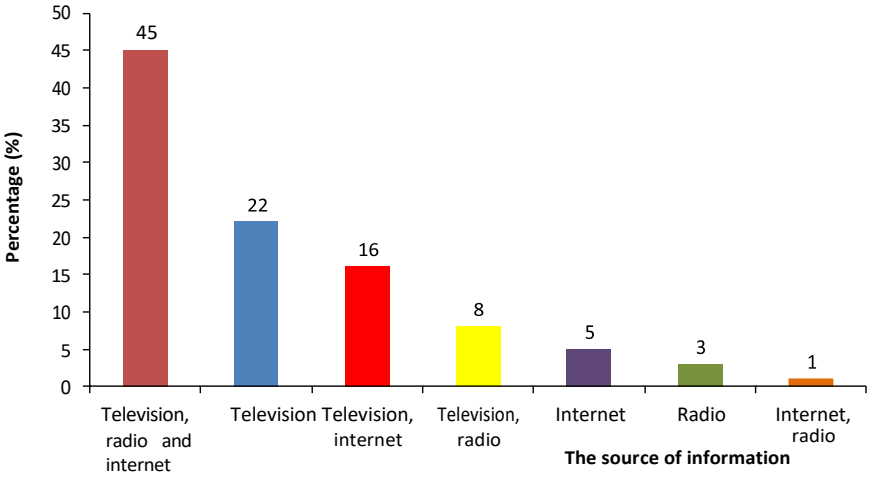

Fig. 2. The sources of information used during natural disasters.

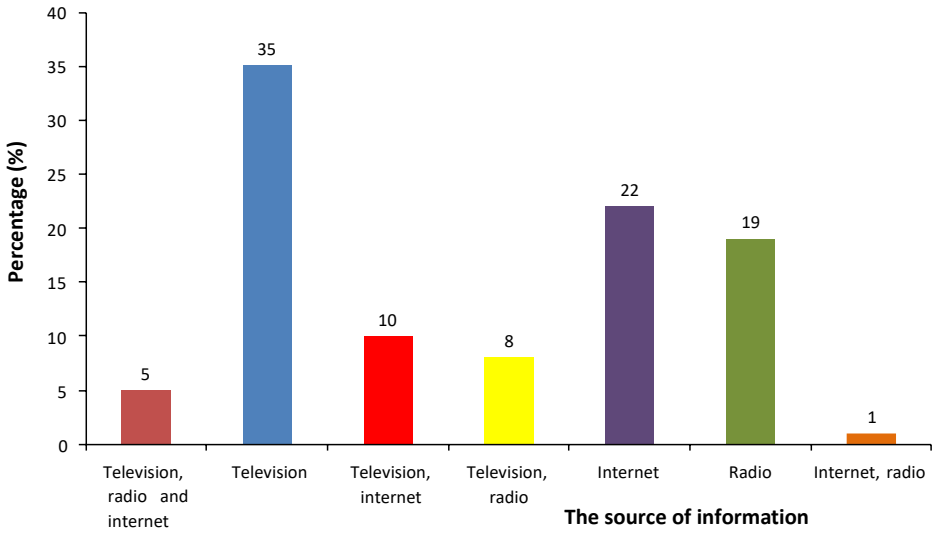

Fig. 3. The sources of information rated as the most valuable sources during natural disasters.

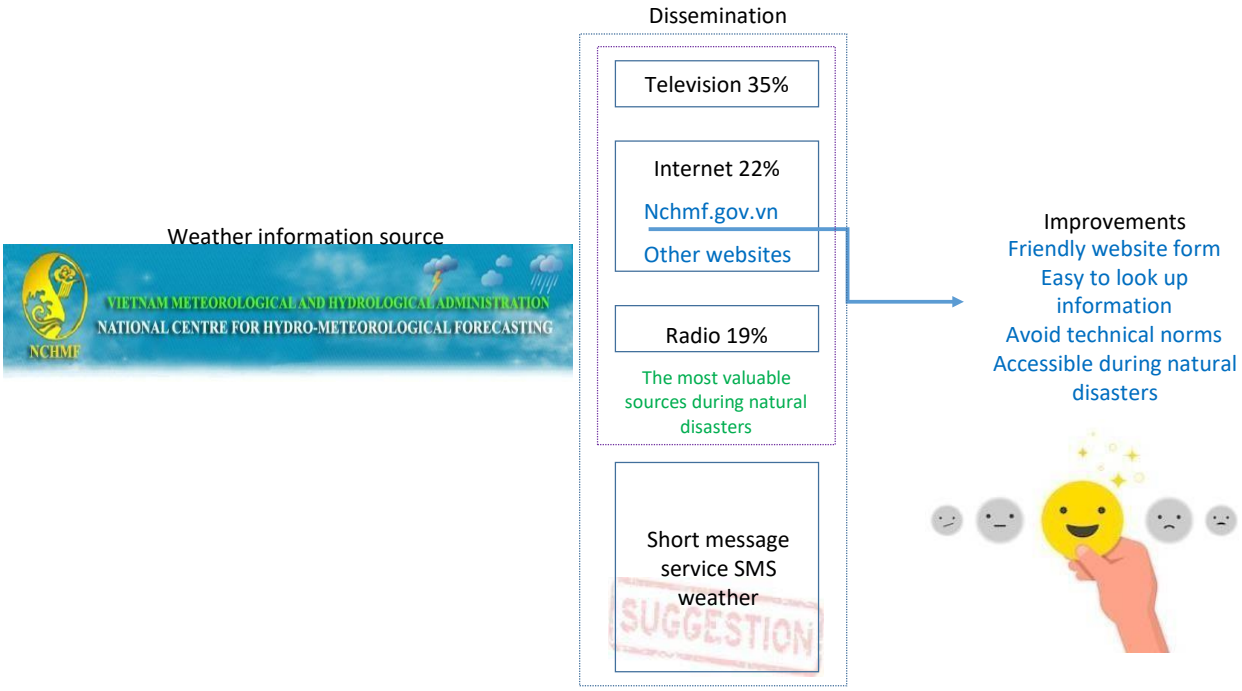

Fig. 4. The most valuable sources during natural disasters.

3.2 Products and services available on the website of the National Center for Hydro-meteorological Forecasting (NCHMF)

The survey indicated that 88% of respondents were of the opinion that NCHMF's website provided sufficiently comprehensive information on the conditions of weather and hydro-meteorology, 4% disagreed and 8% "did not know". When looking up information on forecasts and warnings on the website, 53% of respondents agreed that the information was easily found. Yet 47% did not think so. The unfriendly format of the website was cited by 36% interviewees as a problem (**Fig. 5**). The most common complaint in accessing the information was the slow speed of data retrieval (**Fig. 6**), which is an inherent characteristic of the website itself, but could also be related to the respondents' internet service.

For information dissemination through the website of the NCHMF, the majority agreed that the website provided full information about hydro-meteorological conditions. However, when searching for information on the website, only 53% found the lookup tool easy, because the format of website was unfriendly or its

was slow. Correcting these shortcomings should lead to an increase in the popularity of the website with end-users.

According to a report by the Administrative Division of Viet Nam Meteorological and Hydrological Administration (2014), slow Internet access occurs at times of high demand. During Haiyan typhoon in 2013, the NCHMF's website reached nearly 2,000,000 views. The solution to this problem is to improve site bandwidth and/or local internet speed to enhance the accessibility of the site during disasters.

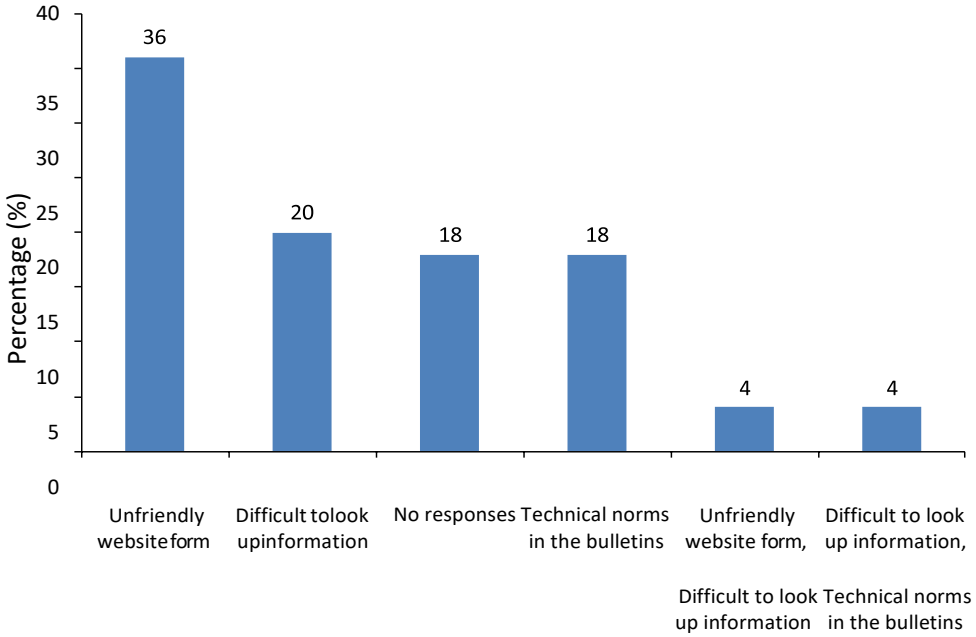

Fig. 5. Common complaints on the NCHMF website.

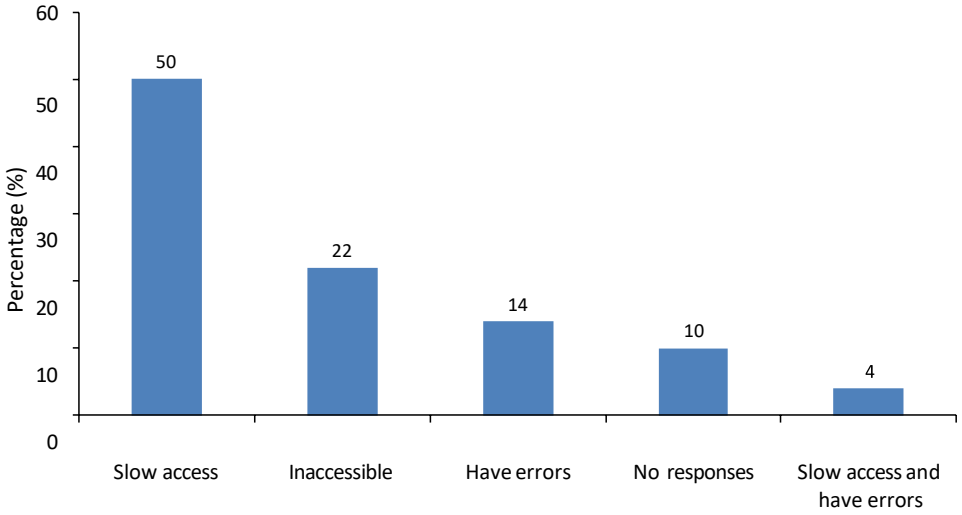

Fig. 6. Common problems in accessing the NCHMF Website.

3.3 Short Message Service (SMS) Weather

Among interviewees, only 9% "regularly" used SMS to access weather information. The proportion of those who "sometimes" used SMS weather was 25% and 66% never used this service. The suggested suitable fee for receiving text messages of fewer than 500 characters was not less than 3000 Vietnamese dong, 3000-5000 Vietnamese dong and 5000 Vietnamese dong (79%, 17% and 4% of respondents, respectively). SMS weather is an infrequently used channel, with only 9% of end-users making frequent use. Of the total number of interviewees, 79% were agreeable to paying for the SMS service, being open to a fee from 3 to 5 thousand Vietnamese dong. While the SMS service is little used in Viet Nam, the number of end-users who agreed to pay for the service is quite high. This suggests an area with potential for investment by hydro-meteorological organizations.

3.4 The level of satisfaction

Prompt receipt of forecasts and warnings of tropical depressions, typhoons and floods, with sufficient time to respond, was affirmed by 62% of respondents. The remaining 38% of respondents reported that the

information was not received early enough. Although 62% of the interviewees found the hydro-meteorological information timely, and 82% agreed to introduce the hydro-meteorological products and services of the NCHMF to their relatives and friends, their level of satisfaction was only 54%. Many businesses believe that customer satisfaction is instrumental to their survival and continued development. Customer satisfaction in turn depends on the quality and performance of suppliers (Grover and Vriens, 2006). Consequently, attaining the end-users' satisfaction of hydro-meteorological products and services will help the hydro-meteorological providers adopt necessary changes to meet the requirements of customers.

With respect to the accuracy of hydro- meteorological forecasts from the NCHMF, rated on a scale of 0 - 100, 70% agreed with a score ranging from 50 - 80, 18% gave a score over 80 and 12% gave a score less than 50. Overall, 54% of the interviewees were satisfied with hydro-meteorological information they received, 44% of the interviewees deemed it acceptable, and 1% were not satisfied with what they received. When asked "Will you recommend products and services of the NCHMF to your relatives and friends?", 82% answered "Yes" and 18% answered "No".

3.5 Willingness to pay for hydro-meteorological products and services

In response to the question "Do you want to receive hydro-meteorological information free of charge?", 78% of the interviewees "Yes" and 22% said "No". Furthermore, 51% agreed to pay for hydro-meteorological information with high accuracy and 54% agreed to pay for the service of information lookup on the website of the NCHMF.

By analyzing the two common channels of information dissemination i.e. website and SMS, it is clear that the willingness to pay for receiving hydro- meteorological information is very encouraging, provided that the accuracy of the information is high. Kluskens et al. (2015) found that 80% of the interviewees were willing to pay for hydro- meteorological products and services. Specifically, they want to pay for early warning services, which may indicate end-users' dissatisfaction with the quality of the current free products. According to Onyago et al. (2014), a large proportion of farmers are willing to pay for weather information tailored to their needs, as they understand the potential financial benefits associated with accurate and timely weather forecasts. Clearly the users are willing to pay if the hydro-meteorological products and services are high-quality and timely.

3.6 The trend of the products and services in the next several years

To improve communication of hydro-meteorological information, 32% of the interviewees suggested that the bulletins should only use images, 23% wanted to add images to the text of the current bulletins, and 28% supported other suggestions (**Fig. 7**). The open question about experiences or extra information the respondents were willing to share revealed a number of suggestions, including establishment of a weather channel, reduction of technical jargon in the bulletins, and the cooperation of telecommunications companies to send SMS messages to end-users who are directly affected by severe weather events.

The survey found a strong preference by end-users for the use of images and a combination of numbers, images and graphs rather than text in bulletins. In contrast, Kluskens et al. (2015) indicated that end-users were satisfied with the products in text format, though they also showed interest in the information presented in the forms of figures, tables and maps.

The question "What is your comment(s) for the future hydro-meteorological products and services?" was answered by 68% of those interviewed. Of the responses, 78% commented that hydro-meteorological information should be updated continuously, accurately and in a timely manner. Twelve percent requested the information to be short, concise, and easy to understand. Seven percent urged the dissemination of the information for as many end-users as possible, and 1% desired the quality and quantity of the information to reach a certain level achieved in other countries regionally and globally. One percent requested information to be updated continuously; and 1% commented on the need of increasing the accuracy for long-term forecasts, monthly and seasonally.

In terms of the future development of hydro-meteorological products and services, some responses in this study coincided with those that emerged from a similar study by Kluskens et al. (2015). The main expectations were for more frequently updated hydro-meteorological information, and providing information in the bulletins in a mixture of images, text, tables, and maps. Other suggestions made in this survey were the use of private weather channels and paid accurate SMS weather data. An additional suggestion for future improvement made by Onyango et al. (2014) was to raise public awareness of how to make the most

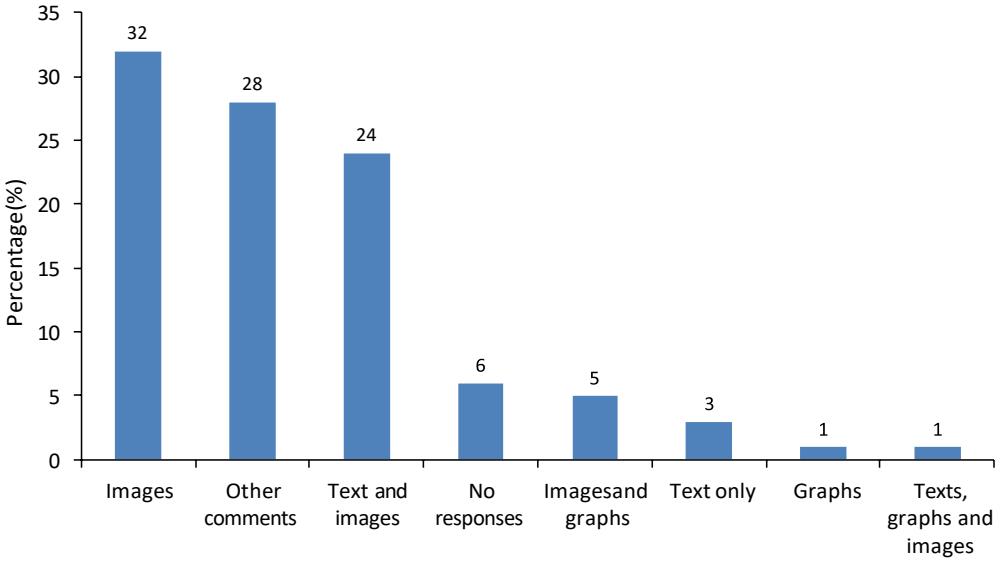

Fig. 7. Suggestions on improvement of NCHMF bulletins.

effective use of hydro-meteorological bulletins to meet the user group's particular needs.

4. Conclusion

This paper assessed end-users' perceptions and needs of current and future hydro-meteorological products and services using a questionnaire administered face-to-face and through mail in 18 provinces and cities in Viet Nam. The results found that the traditional source of hydro-meteorological information, television, remained reliable. Currently, NCHMF is having a strong cooperation with TV in providing hydro-meteorological products and services in Viet Nam therefore, in the near future, this source will be continued to recommend. However, respondents indicated a willingness to make use of new and rapidly advancing digital technologies to obtain weather information. The survey suggested that user experience could be improved by increasing the speed to information retrieval from websites, increasing data and information update frequency, increasing forecast accuracy, and expanding and enhancing the SMS channel. Furthermore, the contents and presentation format of the hydro-meteorological bulletins deserve greater attention, as end-users showed a level of dissatisfaction with the current versions. Understanding the current level of satisfaction of end-users is very important for the Viet Nam Meteorological and Hydrological Administration in general and the National Center for Hydro-meteorological Forecasting to develop new products and services in the near future.

As well as investing in human resources and advanced technology, it is suggested to conduct training courses and forums among managers, decision makers, forecasters and end-users to provide the best possible solutions for the improvement of hydro- meteorological products and services.

This survey was conducted in only 18 of the 63 provinces and 5 centrally-controlled municipalities of Viet Nam. It is recommended to expand the scale of the survey to cover the entire nation, and to repeat the survey every three to five years. It is possible that there are regional differences in information requirements, depending on climate zone, and social and economic factors. A regularly repeated national scale survey will allow for efficient tracking of end-user needs and will keep pace with technological developments. It will also enable swift updating of hydro-meteorological products and services to maintain their relevance and effectiveness across the diverse range of users.

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References

Demuth, J.L., Lazo, J.K. and Morss, R.E., 2011. Exploring Variations in People's Sources, Uses, and Perceptions of Weather Forecasts, Weather, Climate, and Society, **3** (3):177-192.

Grover, R. and Vriens, M. (Eds.)., 2006. The handbook of marketing research: uses, misuses, and future advances. Sage.

Hoa, N.T.P., 2011. "Weather forecasts" on local television in the provinces of the Central Viet Nam (Survey was conducted on Quang Tri, Binh Dinh and Binh Thuan local televisions in the last 6 months of 2010) (2011), University of Social Sciences and Humanities, Viet Nam National University, Hanoi (in Vietnamese). http://repository.vnu.edu.vn/bitstream/VNU_123/12172/1/02050000787.pdf.

Heilig, R., 2010. How an iPhone can change the weather, in: Proceedings of the 26th Conference on Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology, 17 - 21 January 2010, American Meteorological Society, 2010. https:// ams.confex.com/ams/pdfpapers/159723.pdf (accessed 20 November 2017).

Kluskens, R., Perkins, J., Singh, U., Tuan, V.V., Ha, T.T.T. and Huong, P.T., 2015. D-2/D5 Hydromet Services: User Needs Assessment, Current Capacity of Service Delivery and Recommendations, final report of the System Integration and Technical Assistance for Strengthening of Weather Forecasting and Early Warning Systems in Viet Nam (C2-DV1) of the World Bank.

Lazo, J.K., Morss, R.E. and Demuth, J.L., 2009. 300 billion served: Sources, perceptions, uses, and values of weather forecasts. Bulletin of the American Meteorological Society, **90**(6):785-798.

Morss, R.E., Demuth, J.L. and Lazo, J.K., 2008. Communicating uncertainty in weather forecasts: A survey of the US public. Weather and forecasting, **23**(5):974-991.

National Research Council., 2006. Completing the forecast: Characterizing and communicating uncertainty for better decisions using weather and climate forecasts. National Academies Press.

National Research Council, 2006. When Weather Matters: Science and Service to Meet Critical Societal Needs. National Academies Press.

Onyango, E., Ochieng, S. and Awiti, A.O., 2014. Weather and climate information needs of small- scale farming and fishing communities in western Kenya for enhanced adaptive potential to climate change. In Proceedings of Sustainable Research and Innovation Conference: 187-193.

Purcell, K., 2011. Half of adult cell phone owners have apps on their phones. Pew Research Center's Internet & American Life Project.

Song, S.Y., Xue, J.J. and Zhao, R., 2007. Quantitative assessment of public utility of meteorological service in China, Meteorological Soft Science, **3**:1- 13.

Stocker, T. (Ed.)., 2014. Climate change 2013: the physical science basis: Working Group I contribution to the Fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://www. google. com/books (2013).

The administrative Division of National Hydro-meteorological Service, 2014. Social media use in communication of typhoons and tropical cyclones, the report of Viet Nam Meteorological and Hydrological Administration.

Van den Hurk, B.J., Bouwer, L.M., Buontempo, C., Döschere, R., Ercin, E., Hananel, C., Hunink, J.E., Kjellström, E., Klein, B., Manez, M., Pappenberger, F., Pouget, L., Ramos, M., Ward, P.J., Weerts, A.H., Wijngaard, J.B., 2016. Improving predictions and management of hydrological extremes through climate services. Climate Services **1**: 6-11.

World Meteorological Organization, 2008. Survey on improving the delivery of public weather services, Geneva, Switzerland (2008). https://www.wmo.int/pages/prog/amp/pwsp/documents/SurveyResultsOnPWSDelivery.pdf

Yuan, H., Sun, M. and Wang, Y., 2016. Assessment of the benefits of the Chinese Public Weather Service, Meteorological Applications, **23** (1):132-139.

Zabini, F., Grasso, V., Magno, R., Meneguzzo, F. and Gozzini, B., 2015. Communication and interpretation of regional weather forecasts: a survey of the Italian public. Meteorological Applications, **22** (3):495-504.