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Workforce Mapping of Remote Sensing Professionals: A Global Overview Based on Inputs from Social Media

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Abstract:
Spectrum of space products and services are widely recognized across the globe. Whereas satellite augmented devices are being used by billions of people in their lives directly, at the same time satellite provided imageries are being increasingly used for natural resource assessments and monitoring. A growing number of countries are undertaking activities for the development of indigenous basic space technology that will enhance their ability to make the most efficient and effective use of space applications. It is well accepted that nations may cultivate space experts to help understand how space assets can be applied to national priorities which are in turn reflected by availability of workforce. This study is attempted to present the global scenario of remote sensing workforce using query dependent search on world's largest online professional social network LinkedIn. Three key parameters viz. location, sector/industry and experience were used for an appropriate search for the remote sensing (RS). It netted 144,233 results, of which 41.52% of the professionals are having more than 10 years of experience. In terms of geographical distribution, highest percentage of RS professionals were found in the United States i.e. 35.02% followed by India, Canada and U.K, thereby highlighting the need to popularize the advantages of the technology among the RS workforce deficit nations and enhance their capacities in making appropriate use of the same through transfer of technology for the peaceful application of space technology. Majority of the workforce were found to be engaged in research followed by environment services and the information technology sector. However, workforce in higher education showed only 5.5% contribution, displaying lack of sufficient professionals in this sector which stands as a challenge in catering the need of the growing workforce requirement in RS sector as a whole. Though there is considerable variance in the way people use various social networking sites, our study provides a quick insight into otherwise unavailable information on the remote sensing workforce distribution across the globe in a current scenario. It also provides a baseline information for setting national priorities in the space technology related skill development and employment for the societal benefits. Findings made can be utilized for strengthening human capital development in the remote sensing domain across the regions and sectors especially where the labor force departments are either are not in place or not collecting/providing the workforce information in the expedient format.

Keywords: *Remote Sensing, Workforce, Social media, LinkedIn*

1. Introduction

Spectrum of space products and services are widely recognized across the globe. Whereas satellite augmented devices are being used by billions of people in their lives directly, at the same time satellite provided imageries are being increasingly used for natural resource assessments and monitoring. Over the past fifty years, the growth of the commercial remote sensing industry, as well as the increase in data provided by federal agencies coupled with technological development in the field of computing and processing in GIS resulted in identification and tracking of environmental change in more effective way (Dodge & Congalton, 2013). A growing number of countries are undertaking activities for the development of indigenous basic space technology that will enhance their ability to make the most efficient and effective use of space applications. It is well accepted that nations may cultivate space experts to help understand how space assets can be applied to national priorities as well as to have a voice in international efforts related to space. Universities and space-related organizations in several countries have established space technology courses and programmes on the development and operation of small satellites. In the near future, they are expected to play an increasingly important role in a wide range of operational applications (Hauser and John, 2009). With a shift in the developed countries from industrial based economy to knowledge based economy, (Aksari, 2011), role of education in building human capital comprising skills, knowledge and capabilities in regions and across the sectors is well acclaimed. Wide number of universities and institutes are responsible for building capacities training and education in the peaceful uses of the remote sensing technologies. A number of studies have examined anticipated workforce needs in remote sensing and geographic information systems-related fields in the near and long term. Although these studies do not predict a near-term increase in workforce demand, many remote sensing professionals believe that the continuous development of new applications will result in at least a slow, steady rise of professional positions in the remote sensing industry

(DeCosmo, 2002). However, efforts in this direction seemed to develop in fragmented way with weak links between education and geo-informatics market, even among the education institutions and the universities (Krevs, 2009). It is crucial to strengthen these links to ensure effective human capital development in the remote sensing across the regions and sectors. This can be affectively achieved the internet surveys and they are becoming increasingly sophisticated and easy to use. Social networking sites provides an influential platform.

2. Methodology

In this study search on remote sensing professionals was carried out using three key parameters viz. region, sector, and experience on the online social network LinkedIn with over 300 million members across the globe. Though, people search is one of the primary activities on the site, for which LinkedIn members are both the users and the corpus (Huang et al, 2014), it can also be effectively used to conduct research on organizations and industries of interest (Thew, 2008). State et al. (2014), used LinkedIn to study the migration of professionals to the U.S. based on evidence from LinkedIn. The type of search performed is also query dependent (Huang et al, 2014) where item-to- item collaborative filtering is used. That is, for each entity type on the site, there exists a navigational aid that allows members to browse and discover other content, known as browse map (Wu et al, 2014). It also allows to search all professionals irrespective of the network distance, hence making it more robust.

3. Results & Discussion

Web of LinkedIn, search on "Remote sensing'' netted 144,233 results for people as accessed in May, 2015. Further mining of RS professionals in terms of geography and preferred sectors/industry are presented in table 1 & 2 respectively. Since experience based insights are very useful in further growth and development of a technology or we can say the future acceptance of it, we also mapped the RS workforce professionals using 10 years rule (Table 3).

3.1. Mapping by Region

Science and technology drive innovation, and their importance to economic growth is recognized throughout the world. The ability of a nation to drive innovation and economic progress in turn depends on its science and technology capacity. This includes "the infrastructure, investment, institutional and regulatory framework, and personnel available to conduct scientific research and technological development. Out of total roughly 192 economies in the world the twenty studied countries contributed to 73.44 % of total RS professionals across the globe (Table 1). Highest percentage of RS professionals were found in the United States i.e. 35.02%. India, Canada and U.K are the three major economies in descending order with the highest number of RS professionals next to U.S. However, it is noteworthy to mention there is a huge gap in workforce distribution in these countries and U.S. Seven countries viz. Australia, Brazil, Netherlands, Germany, South Africa, Indonesia and China were found to have workforce distribution in the range 1-3.49%. Bottom nine countries studied were found to have less than 1% of global workforce distribution. Remaining 172 economies that were not taken up in this study contributed to i.e. 26.56 % of RS workforce many of them not so surprisingly some even hitting zero. Low count of RS workforce in China, japan, Korea etc. in spite of their own space programmes can be attributed to low penetration of LinkedIn in these regions due to several factors among which the cultural factors are most significant.

S. No.	Country	Count	Percentage of Total
1.	United States	50513.00	35.02
2.	India	12005.00	8.32
3.	Canada	9610.00	6.66
4.	United Kingdom	8599.00	5.96
5.	Australia	5028.00	3.49
6.	Brazil	3007.00	2.08
7.	Netherlands	2781.00	1.93
8.	Germany	2456.00	1.70
9.	South Africa	2225.00	1.54
10.	Indonesia	1959.00	1.36
11.	China	1451.00	1.01
12.	Sweden	1050.00	0.73
13.	Switzerland	883.00	0.61
14.	Malaysia	820.00	0.57
15.	Russian Federation	451.00	0.31
16.	Japan	437.00	0.30
17.	Singapore	390.00	0.27
18.	Hong Kong	169.00	0.12
19.	Bangkok	84.00	0.06
20.	Other Economies	40315.00	27.95
Total		**144,233**	**100**

Table1: Distribution of RS professionals in terms of geographical region

3.2. Mapping by Sector

Remote sensing today finds its application in almost every aspect of natural resource mapping, monitoring and management. These three M's capability of satellite data products is critical to sustainable, continued economic and social development of the nations. This study identified 10 major sectors represent 69.66% of the total RS workforce in which the RS professionals are primarily working. Research, environments services and the Information technology and services represented the prime sectors with the maximum distribution of the RS workforce. Since research is a logical and systematic search for new and useful information on a particular topic, RS in our case, highest score of workforce in research indicate wide range of unexplored and hidden potential of RS being investigated by the researchers. Since the finding are finally utilized to address the environmental issues such as terrestrial, freshwater/marine or atmospheric, results obtained showed second highest score of RS workforce in environment sector. Again it is noteworthy to mention that remote sensing technology is interdependent on the Information technology (IT) and services for processing and analyzing the data hence converting it into usable information though Geographic Information Systems (GIS). This is further reflected in the equally high percentage of workforce in IT sector as that of the environment services. However, there is a large gap in the teaching workforce as mapped in this study. Roughly 6% of the RS workforce were found to be engaged in education/higher studies as compared to the total remote sensing workforce netted on the LinkedIn. This indicates a need for encouraging and recruiting more professionals to join RS education sector to meet the growing demand for professionals in various other sectors. This also somehow can also be attributed to the popularity of e-learning and distance learning programmes among the professionals due to promised benefits such as economic, organizational and pedagogical advantages (Koenig &Schiewe, 2006).

S.No.	Sector / Industry	Count	Percentage of Total
1.	Research	21410	14.84
2.	Environmental Services	19001	13.17
3.	Information Technology and Services	18460	12.80
4.	Higher Education	8055	5.58
5.	Civil Engineering	6717	4.66
6.	Oil & Energy	6553	4.54
7.	Defense & Space	5459	3.78
8.	Government administration	5372	3.72
9.	Mining & Metals	3898	2.70
10.	Education Management	1656	1.15
11.	Architecture & Planning	1553	1.08
12.	Management Consulting	993	0.69
13.	Nonprofit Organization Management	922	0.64
14.	Public Policy	269	0.19
15.	Insurance	257	0.18
16.	Legal Services	109	0.08
17.	Business Supplies and Equip	73	0.05
18.	others	43476	30.14
Total		**144,233**	**100**

Table 2: Distribution of RS professionals by Sectors/ Industry

3.3. Mapping by Experience

Experience in a particular domain is considered as the first and foremost to reach very high levels of performance (Ericsson, 2006). Knowledge develops over time, through experience. Prime benefits of experience is that it provides a historical perspective from which to view and understand new situations and events (Davenport &Prusak, 2005). These experience-based insights arevery useful in further growth and development of a technology or we can say the future acceptance of it. In our study we found that whereas 41.52% of the professionals are having more than 10 years of experience remaining 53.81 were found to have less than 10 years' experience. Though there is low popularity of Linked in among the people of higher age group professionals the demographics is shifting to old users (Hampton et al., 2011). With this consideration and further, bearing in mind the 10 years rule applicable to all domains of expertise (Ericsson et al., 1993), results obtained in this study shows that the RS workforce is in transition stage as on date and it will take time to make remote sensing profession a fully flourished one. This will depend on more innovative ways in which RS would be used in future along with the returns to the professionals in terms of compensations and other benefits. This will also be guided by the space programme and interests of the various nations depending upon science, technology and political developments in the emerging space nations. Nonetheless, the uniform recognition among all the nations that space is important for national development will keep promoting the space sustainability (Ansdell et al., 2011) and hence the profession.

S. No.	Years of Experience	Count	Percentage of Total
1	Less than 1 year	4516	3.13
2	1 to 2 years	12012	8.33
3	3 to 5 years	24675	17.11
4	6 to 10 years	36408	25.24
5	More than 10 years	59891	41.52
6	Other (Free-Lance/ Part time)	6731	4.67
Total		**144,233**	100.00

Table 3: Distribution of RS professionals by Sectors/ Industry.

4. Discussions

Three key parameters viz. location, sector/industry and experience examined in this study shows that majority of the RS workforce is represented in the U.S. and the India ranks second among the number of RS Professionals followed by India, Canada and U.K. Lower ranking of China as observed in our study in spite of the fact that it has well developed space programmes and remote sensing technology is due to the fact that social media platforms in China are more domestic in nature. However, it is important to mention that networking provides significant professional opportunity of a diverse network, wherein the low cost of link formation can lead to networks with heterogeneous relationship strengths (Xiang et al., 2010). The network of RS professionals in different social locations in society indeed provide different types of resources. The more different people someone knows, the more likely he or she is to have access to a range of resources. It is characterized by interactivity across multiple horizontal connections, which produce in aggregate a mutable, collectively generated user experience (Schein et al., 2010).

There is a need to assist the bottom ranking RS workforce nations as mapped in this study in making appropriate use of technology through capacity building and transfer of technology for the peaceful application of space technology for the mankind. In terms of the sectors, research followed by environment services and the information technology shows a positive setting for the remote sensing technology. However, lower workforce in the education sector demonstrates lack of sufficient professionals to cater the need of the growing workforce demand in RS sector as a whole. Workforce opportunities in RS are further highlighted by the growing number of young RS professionals across the globe every year and that there are equal number of more than 10 years' experience professionals as they are the young ones. Though the efforts are underway for small scale entrepreneurial and agricultural uses of remote sensing along with the emphasis on more automated applications for tele-education, telemedicine, and tele business, more consolidated attempts are needed especially in the technology deficient nations if remote sensing has to excel its cause in societal development in the global village.

5. Conclusions

Online social networking is known to present both opportunities and risks. Though there are issues related to internet penetration in several countries, the way people use various social networking sitesand also the popularity of LinkedIn among the various age groups, the advent of smartphone, the emergence of mobile operating systems, the development of mobile apps, the increase of network coverage, the falling cost of data and affordability, changing social norms toward mobile device ownership, falling cost of devices and overall increase in utility of the mobile internet etc. have resulted in expansion of social networking(ITU, 2013). Clues derived from such social networks thus presents an innovative approach in developing baseline information in setting national priorities related to skill development and workforce mapping. The study thus presented, provides a quick insight into otherwise fragmented information on the remote sensing workforce distribution across the globe. It can be utilized for strengthening human capital development in the remote sensing domain across the regions and sectors especially where the labor force departments are either are not in place or not collecting/providing the workforce information in the expedient format.

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