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GIS based land suitability analysis using AHP model for urban services planning in Srinagar and Jammu urban centers of J&K, India

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ABSTRACT

Rapid urbanization and consequent haphazard growth of cities result in deterioration of infrastructure facilities, loss of agricultural land, water bodies, open spaces, and many micro-climatic changes. This unprecedented growth in city population put pressure on urban amenities and led to their uneven distribution. The Srinagar and Jammu cities witnessed alarming population growth rates in the last thirty years, thus resulted in various problems like pollution, traffic jam, leap-frog development, uneven provision of urban amenities etc. The present study attempted to find out the urban land suitability for the provision of urban amenities. Land use suitability assessment is a key determinant in any urban and suburban planning and decision-making process. The suitability assessment is carried out through AHP model using a set of criteria involving geo-physical and socioeconomic variables. The variables taken for the study are slope, altitude, land use/land cover and existing amenity status. The unit of study is a municipal ward. For better urban planning and suitable decision making, the study provided the information not only on the existing urban land use pattern and existing amenity status but also on suitability of land for the establishment of urban amenities in future.

1. Introduction

The access to basic amenities like electricity, drinking water, toilet facility, sanitation, healthcare facilities and solid waste management are critical determinants of urban quality of life (Bhagat, 2010). Though these infrastructures form an important and integral part of life of any community, either rural or urban but they are unequally distributed over space. Inequalities exist between spatial units as they do between individuals (Henderson, Shalizi, & Venables, 2001; Anderson & Pomfret, 2004; Kenbur and Venables, 2005). Many empirical findings have shown that facilities are unequally distributed in our communities such that the vast majority of the people are caught in a never ending struggle to gain access to these infrastructures in order to improve their quality of life (Eyles, 1996; Oyerinde, 2006).The spatial variations in availability and access to infrastructure result in spatial disparities in living standards both within and between regions and localities (Madu, 2007). The essence of urban planning is to provide adequate and equitable services to all groups. They have influence and impact on regional patterns of development, environmental impacts and on maintaining socially acceptable levels of quality of life (Murray et al. 1988). Knowledge of the nature and pattern of distribution of existing facilities in any region is needed before we make any attempt to project and plan their future development. Srinagar and Jammu

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cities, nestled in the western Himalayas are famous for their tourist attractions and in fact the cities have very fragile ecosystem. The cities have received spurt urban growth in the last thirty years which put tremendous pressure on the social amenities of the cities (Zahoor et al., 2017). Urban growth inevitably decreases the sustainability of land use and the ecosystem. Thus, the application of innovative techniques is urgently necessary to advance the concept of sustainable growth (Aburas, 2015). The planning body of the cities failed to keep pace with the urban sprawl of the cities, thus leading to uneven distribution of civic amenities in the cities. This uneven distribution of civic amenities in the twin cities of Srinagar and Jammu affect the physical quality of life of the city dwellers.

Suitability analysis is the process and procedures used to establish the suitability of a system according to the needs of a stakeholder. Urban development and migration to urban areas are global phenomena's especially in third world countries. Thus, many small cities and isolated populations are rapidly changing into large metropolitan cities (Jain & Subbaiah, 2007).This rapid increase of urban population causes high level impact on the urban environment and creates many problems such as unplanned sprawl, inadequate housing facilities, traffic congestion, insufficient drainage, sewerage problem and lack of other amenities (Liu, 1998). In this context, finding suitable area for further development or evaluation of land suitability for urban land use planning to overcome undesirable urban growth and protect environment around cities becomes all the more important (Kazil & Ali, 2015). In most of the third world countries people are constructing residential buildings without considering resources for these new residential areas. Therefore, it becomes the government's problem to provide required resources for these areas. In order to find suitable site for construction of an amenity, it is required to use sophisticated analysis with consideration of large numbers of critical issues such as technical, environmental, physical, social and many others. Site suitability analysis is the process of determining the fitness of a given tract of land for a defined use (Steiner and McSherry, 2000). Remote Sensing, GIS, GPS and AHP method is a vital tool for identification, comparison and multi-criterion decision making analysis of urban development site's proper planning and management (Shukla, 2017 and Sandipan, 2013).

2. Literature review

Geographical and political research on urban service delivery has been proliferated during the past two decades (Davies, 1968; Pinch, 1984). Some scholars have investigated the factors which account for higher levels of service in certain neighborhoods (Cingranelli, 1981; Mladenka, 1989) and focused in particular on the role of distributive politics (Miranda & Tunyavong, 1994). Others have examined patterns of accessibility to certain services and the geographic relationship between service deprivation and area deprivation (Knox, 1978; Pacione, 1989). In order to fulfill these and other needs, man requires access to certain facilities such as market, housing, water supply, electricity and adequate transportation (Aderamo and Aina, 2011).

Since site selection and suitability process are related to geospatial issues, geographical information system (GIS) allows using data related parameters for suitability modelling. One of the advantages of using GIS in site suitability analysis is the capability of GIS in development of alternative scenarios for urban development. Suitability analysis in a GIS context is a geographic or GIS-based process used to determine the appropriateness of a given area for a particular use. The basic premise of GIS suitability analysis is that each aspect of the landscape has intrinsic characteristics that are to some degree either suitable or unsuitable for the activities being planned. Suitability is determined through systematic, multi-factor analysis of the different aspects of the problem (Murphy, 2005). Model inputs include a variety of physical, cultural, and economic factors. The results are often displayed on a map that is used to highlight areas from high to low suitability. A GIS suitability model typically answers the question, 'where is the best location? Land suitability analysis is used for site selection, impact studies and land use planning (Edward et, al. 2010). Land use planning plays an important role in site development, urban renewal and achievement of sustainable urban development (Wang et. al, 2013, 2014). Suitability analysis is critical for both marketing and merchandising purposes (Dramowicz, 2005). The GIS has different applications in urban health studies (Dom et al., 2012a, 2012b) and can also be used as a decision support tool to allocate health services so that they are geographically accessible for the population that they intend to serve (Phillips *et al.* 2000, Boulos, Roudsari, & Carson, 2001). There are various methods used in GIS in evaluating land suitability, for example, Graymore, Wallis, and Richards (2009) produced an index of regional sustainability spatial decision support system; Saaty (2007) used an analytic network process; and Mohit and Ali (2006) integrated an analytic hierarchy process with GIS. GIS plays a vital role in planning for many decades of land-use suitability mapping and modelling (Malczewski, 2004 and Malczewski, 2006). The purpose of the current study is to find land suitability for better urban service delivery mechanism of Srinagar and Jammu urban centers of Jammu and Kashmir, India.

3. Data and methods

Srinagar city is located between 34°00′–34°14′ N latitudes and 74°43′–74°52′E longitudes. It is the summer capital of the state of Jammu and Kashmir. It is situated at an altitude of 5200 feet above the mean sea level (Bhat, 2008). The city is spread over a length of 29 Kms and an average depth of about 6 Kms on either side of the Jhelum river. The total area of the city at present is 278.1Km^2 excluding cantonment area under defense use and its total population is 1,147,417 (Census of India, 2011). Jammu city, the city of temples and the winter capital of Jammu and Kashmir lies between 32°38′–32°48′North latitude and 74 °47' - 74 °50' East longitude. It is located on the banks of the river Tawi at an elevation of 1030 feet above the sea level (Hussain, 2006).

In the present study, the important physical parameters which are considered for the suitability analysis are; (i) Slope (ii) Altitude (iii) Land use/ Land cover and (iv) Existing urban amenities like educational and health institutions, ration depots, waste collection points etc. The inventory of these parameters has been carried out using remote sensing and GIS techniques. These parameters are then given weightage as per the Saaty's AHP (Analytic Hierarchy Process) method (Saaty, 1980) by creating a separate field in each layer in Arc GIS 9.1 software. Each class associated with each layer are given a rank and stored as separate field in geo-database. The

Table 1
Saaty's Scale.

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight importance	
3	Moderate	Experience and judgment slightly favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favour one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If activity i has one of the above non-zero numbers assigned to it when compared with activity *j,* then *j* has the reciprocal value when compared with *i*	A reasonable assumption
1.1–1.9	If the activities are very close	May be difficult to assign the best value but when compared with other contrasting activities the size of the small numbers would not be too noticeable, yet they can still indicate the relative importance of the activities.

product of weightage and rank are computed and stored in another field. These vector layers are then integrated in a GIS environment.

3.1. The analytic hierarchy process

To make a decision in an organized way to generate priorities we need to make comparisons and need a scale of numbers that indicates how many times more important or dominant one element is over another element with respect to the criterion or property they are compared. The Analytic Hierarchy Process (AHP) is a theory of measurement through pair wise comparison. The comparisons are made using a scale of absolute judgements that represents how much more; one element dominates another with respect to a given attribute. The derived priority scales are synthesized by multiplying them by the priority of their parent nodes and adding for all such nodes (Saaty, 2007). In the present study, for the determination of suitability analysis, preference is given to physical and socio-economic parameters by using correlation analysis module. The correlation between the combined urban amenities deficiency status and the selected parameters gives the preference of parameters taken for the study. The Saaty's scale is presented in Table 1.

The flow chart of the methodology adopted is presented in Fig. 1.

4. Results and discussion

4.1. Suitability analysis for the provision of amenities in Srinagar city

The identification of suitable land for urban development is an important fundamental work in urban planning. The physical parameters affecting the suitability of land are discussed below. The cumulative effect of these factors determines the degree of suitability and also helps in identification of the limitations of the land for urban development. The various map layers generated to serve the purpose are;.

4.1.1. Land use / Land cover map

Land use/Land cover map has been prepared by using satellite image. The land use/cover information help in formulation of policies and programmes for urban development. It has been observed that thirty percent area is under built up followed by plantation (twenty two percent), agriculture (twenty five percent), horticulture etc. Lowest area is under wetland category (1.26 percent) [Table 2]. The land use / land cover map is shown in Fig. 2b.

4.1.2. Slope map

The slope map clearly indicates that maximum wards of the city have gentle slope of less than 3°. The Zabarwan foot hills area and lower parts of peripheral wards of Dara, Harwan, Alesteng etc. have slope of 3–13°. However, the Shankaracharya, Hariparbat fort and upper areas around Dara, Alesteng, Zakura have slope more than 13° (Fig. 2c).

4.1.3. Altitude map

The altitude map (Fig. 2a) shows that Srinagar city is located at an altitude of 1600 m. Ninety percent area of the city has 1600m elevation/altitude. However, the north-eastern part of the city has altitude between 1600 to 1700 m. The wards having high altitude are peripheral wards, *viz*, Khonmoh, Dara, Alesteng etc.

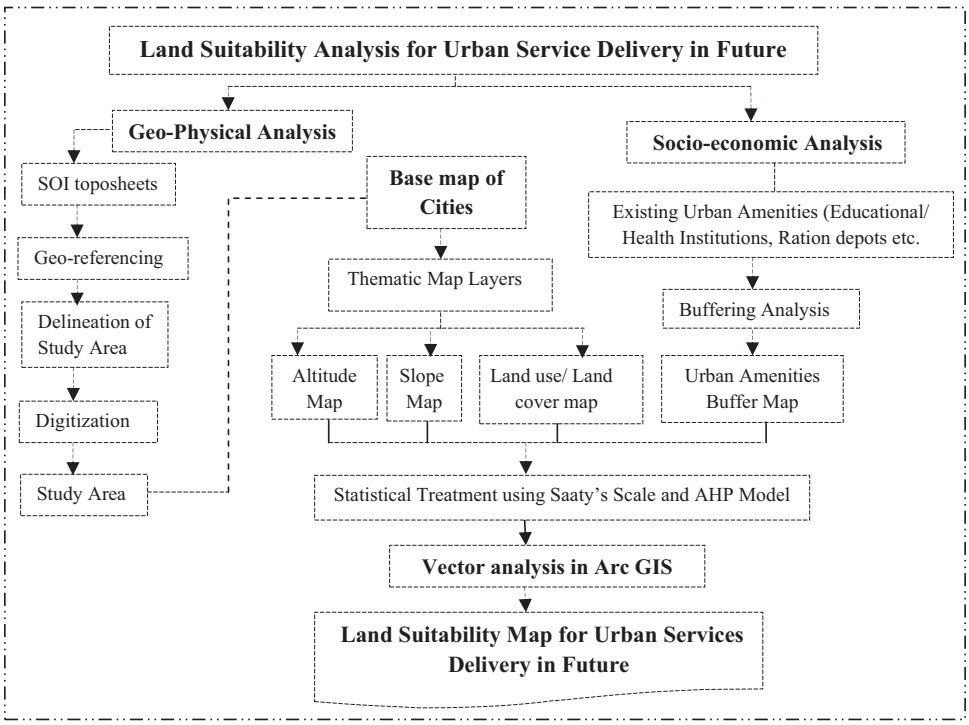


Fig. 1. Flow chart of methodology.

Table 2
Land use/ Land cover of Srinagar City.
Source: *Landsat-8 OLI (Operational Land Imagar-2015)*

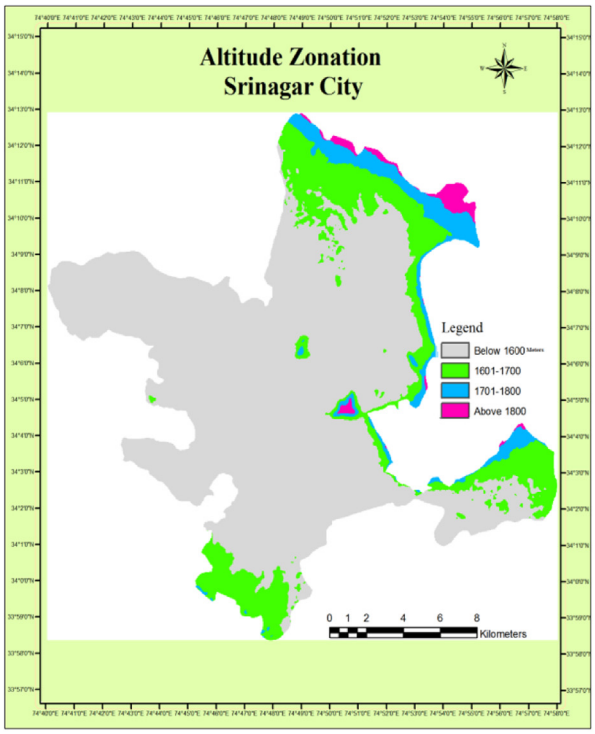
Land use/Land cover Category	Area Km^2 (Percentage)
Plantation	64.55 **(21.95)**
Wetland	3.719 **(1.26)**
Scrub	6.60 **(2.25)**
Forest	3.76 **(1.28)**
Horticulture	32.53 **(11.06)**
Built up	88.43 **(30.07)**
Agriculture	73.45 **(24.98)**
Water body	21.05 **(7.16)**
Total	**294.12 (100)**

4.1.4. Slope map

The slope map clearly indicates that maximum wards of the city have gentle slope of less than 3°. The Zabarwan foot hills area and lower parts of peripheral wards of Dara, Harwan, Alesteng etc. have slope of 3–13°. However, the Shankaracharya, Hariparbat fort and upper areas around Dara, Alesteng, Zakura have slope more than 13° (Fig. 2c).

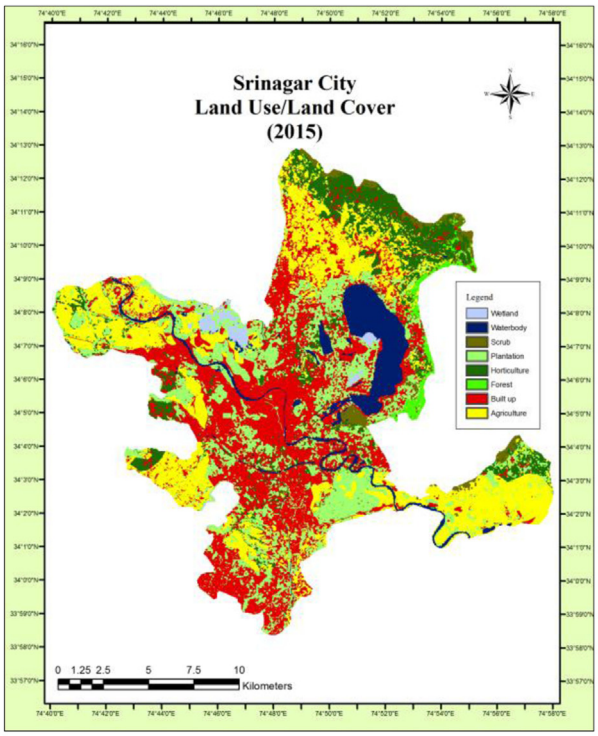
4.1.5. Altitude map

The altitude map (Fig. 2a) shows that Srinagar city is located at an altitude of 1600 m. Ninety percent area of the city has 1600m elevation/altitude. However, the north-eastern part of the city has altitude between 1600 to 1700 m. The wards having high altitude are peripheral wards, *viz*, Khonmoh, Dara, Alesteng etc.



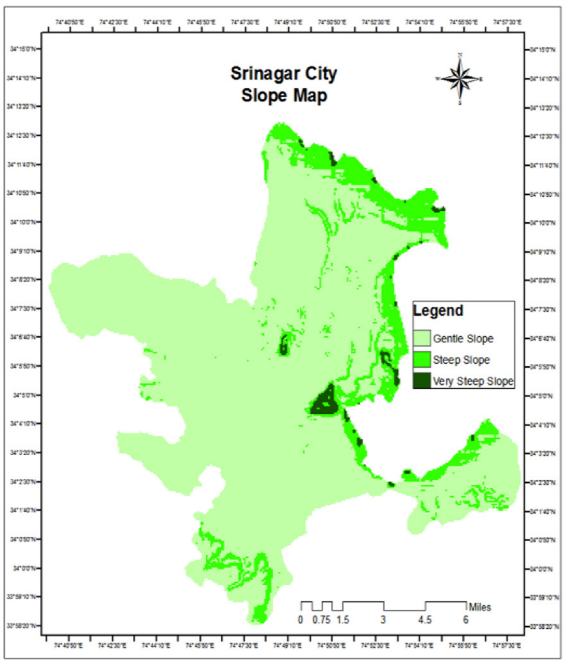
Source: SRTM DEM 30m Resolution, 2012

a



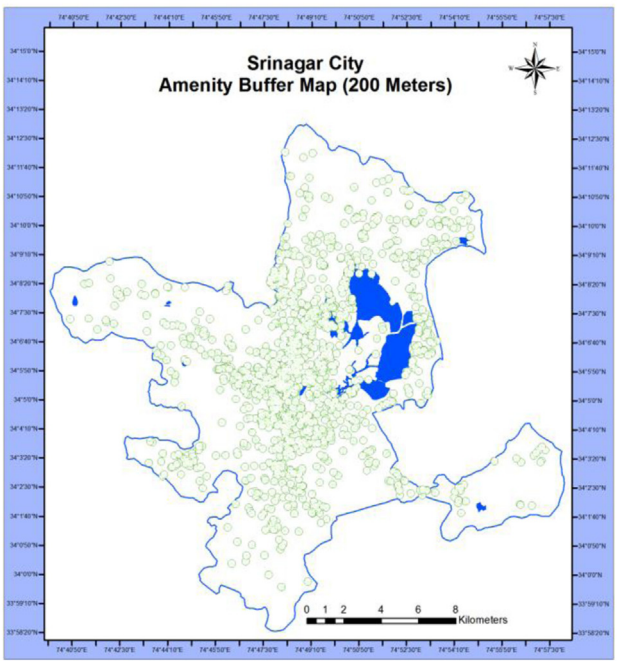
Source: *Landsat-8 OLI (Operational Land Imagar-2015)*

b



Source: SRTM DEM 30m Resolution, 2012

c



Source: Compiled from various sources of data Srinagar

d

Fig. 2. (a-d): Various map layers for suitability analysis.

Table 3
Importance matrix for suitability analysis.

	V.S	S	G	H	M	L	Ag	B	F	Sc	Wl	Pl	W	Ef	W.S	W.I
V.S	**1.00**	7.00	9.00	3.00	7.00	9.00	5.00	1.00	4.00	8.00	1.00	6.00	1.00	1.00	**0.15**	**15.36**
S	0.14	**1.00**	1.29	0.43	1.00	1.29	0.71	0.14	0.57	1.14	0.14	0.86	0.14	0.14	**0.02**	**2.19**
G	0.11	0.78	**1.00**	0.33	0.78	1.00	0.56	0.11	0.44	0.89	0.11	0.67	0.11	0.11	**0.02**	**1.71**
H	0.33	2.33	3.00	**1.00**	2.33	3.00	1.67	0.33	1.33	2.67	0.33	2.00	0.33	0.33	**0.05**	**5.12**
M	0.14	1.00	1.29	0.43	**1.00**	1.29	0.71	0.14	0.57	1.14	0.14	0.86	0.14	0.14	**0.02**	**2.19**
L	0.11	0.78	1.00	0.33	0.78	**1.00**	0.56	0.11	0.44	0.89	0.11	0.67	0.11	0.11	**0.02**	**1.71**
Ag	0.20	1.40	1.80	0.60	1.40	1.80	**1.00**	0.20	0.80	1.60	0.20	1.20	0.20	0.20	**0.03**	**3.07**
B	1.00	7.00	9.00	3.00	7.00	9.00	5.00	**1.00**	4.00	8.00	1.00	6.00	1.00	1.00	**0.15**	**15.36**
F	0.25	1.75	2.25	0.75	1.75	2.25	1.25	0.25	**1.00**	2.00	0.25	1.50	0.25	0.25	**0.04**	**3.84**
Pr	0.13	0.88	1.13	0.38	0.88	1.13	0.63	0.13	0.50	**1.00**	0.13	0.75	0.13	0.13	**0.02**	**1.92**
Wl	0.11	7.00	9.00	3.00	7.00	9.00	5.00	1.00	4.00	8.00	**1.00**	6.00	1.00	1.00	**0.14**	**14.25**
Pl	0.17	1.17	1.50	0.50	1.17	1.50	0.83	0.17	0.67	1.33	0.17	**1.00**	0.17	0.17	**0.03**	**2.56**
W	1.00	7.00	9.00	3.00	7.00	9.00	5.00	1.00	4.00	8.00	1.00	6.00	**1.00**	1.00	**0.15**	**15.36**
Ef	1.00	7.00	9.00	3.00	7.00	9.00	5.00	1.00	4.00	8.00	1.00	6.00	1.00	**1.00**	**0.15**	**15.36**
	5.69	**46.08**	**59.25**	**19.75**	**46.08**	**59.25**	**32.91**	**6.58**	**26.33**	**52.66**	**6.58**	**39.50**	**6.58**	**6.58**	**1.00**	**100.02**

V.S – very steep slope; S – steep slope; G – gentle slope; H – high altitude; M – medium altitude; L – low altitude; Ag – agriculture; B – built up; F – forest; Sc – scrub; Wl – wetland; Pl – plantation; W – water body; Ef – existing facilities

4.1.6. Existing amenity buffer map

The buffer map of 200 m has been taken because maximum amenities are located around the old core of the cities which spans over around 200 to 300 m (Master Plan, 2000-2021). Fig. 2d depicts that the core wards of the city have adequate existing amenities. The map clearly shows that the peripheral wards lack this amenity. The northern, south-western, north-western wards of the city in general lack educational amenity. The wards lacking the amenity are Zakura, Bud Dal, Lokut Dal, Maloora, Lawaypora, Humhama, Khumani Chowk and Khonmoh.

4.1.7. Integrated analysis for urban suitability

As per the methodology of determination of suitability analysis, weightage is given to physical parameters, by comparing each parameter with respect to the other parameter. The weightage assigned for all the parameters according to Saaty's scale is shown below in Table 3.

Finally all the map layers were combined in a GIS environment to prepare the final urban suitability model based on weighted index model. The urban land use suitability map has been grouped into three categories namely highly suitable, moderately suitable, and less suitable. The urban suitability map is shown in Fig. 3.

The Fig. 3 exhibits that since the core wards of the city have adequate urban amenities as compared to peripheral wards, therefore peripheral wards in general show medium level of suitability for establishing urban amenities. These peripheral wards though have inadequate urban amenities but due to several factors like high altitude, steep slope, inaccessibility etc. these wards fall in medium level of suitability. The municipal wards lying between core and peripheral wards depict high suitability for the provision of urban amenities because of favourable slope, altitude, accessibility etc. plus lack of existing urban amenities. The wards showing high suitability are Mehjoornagar, Iddgah, Tealbal, Pandrathen, Hassanabad, Jogilangar, Palpora etc. followed by peripheral wards, *viz,* Dara, Alesteng, Khonmoh, Humhama, Zakura, Harwan etc. which show medium level of suitability. The core wards of the city like Lalchowk, Wazirbagh, Nawab Bazar, Mukhdoom Sahib, Kawdara, Zadibal etc. exhibit low suitability on account of having adequate amenities. Moreover, the maximum area in these old city wards is under built up category, therefore having shortage of space/area for the establishment of urban amenities. The wards Bud dal and Lokut dal also show low suitability as being located on the shores of Dal lake on which the construction is prohibited. The suitability pattern of urban amenities in Srinagar city is depicted in Fig. 3. It is evident from the figure that the north-eastern, south-eastern and north-western parts of the city exhibit medium level of urban suitability. The inner wards of the city in a circular fashion posses low suitability. The high suitability is depicted by the intermediate wards lying between core and peripheral wards.

4.2. Suitability analysis for the provision of amenities in Jammu city

The identification of suitable land for urban development is an important fundamental work in urban planning. The physical parameters affecting the suitability of land are discussed below. The cumulative effect of these factors determines the degree of suitability and also helps in identification of the limitations of the land for urban development. The various map layers generated to serve the purpose are;.

4.2.1. Land use / Land cover map

The Land Use / Land Cover map of Jammu city has been prepared by using satellite imagery. From the Table 4b, it has been observed that 63.42 percent area is under built-up, followed by Plantation (13.10 percent) and Agriculture (11.12 percent). Lowest area is under water bodies (0.15 percent) [Table 4]. The land use / land cover map is shown in Fig. 3.

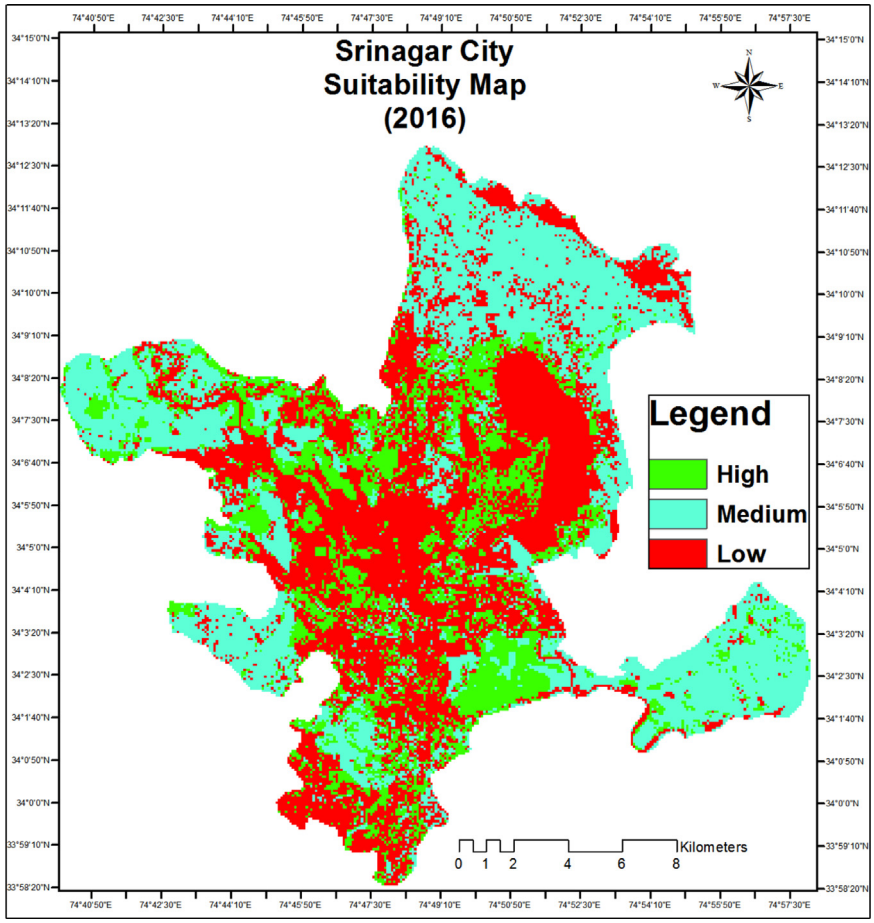


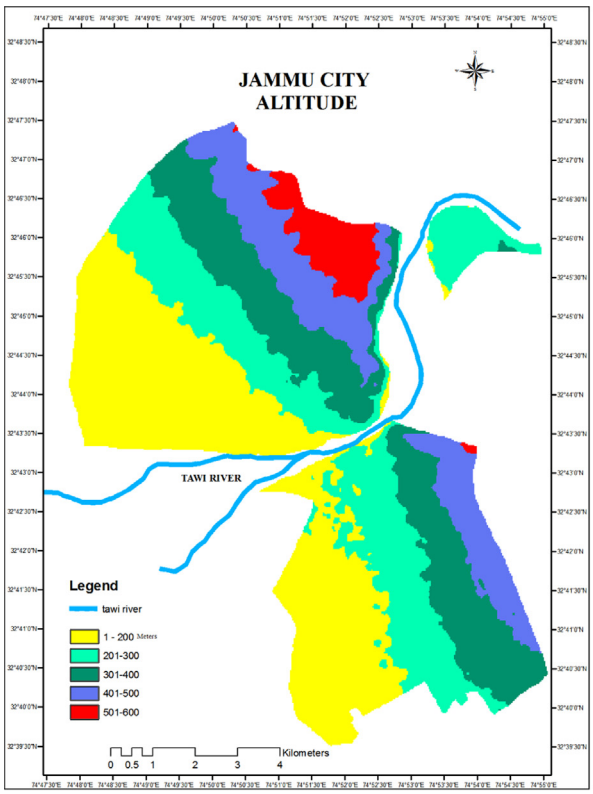
Fig. 3. Suitability map for location of amenities in Srinagar city.

Table 4
Land use/ Land cover of Jammu City.
Source: *Landsat-8 OLI (Operational Land Imagar-2015)*

Land use/ Land cover category	Area Km^2 (Percentage)
Built up	50.46 **(63.42)**
Agriculture	8.85 **(11.12)**
Forests	7.94 **(9.98)**
Water body	0.12 **(0.15)**
Plantation	10.42 **(13.10)**
Wasteland	0.58 **(0.73)**
Parks	1.20 **(1.51)**
Total	79.57 **(100)**

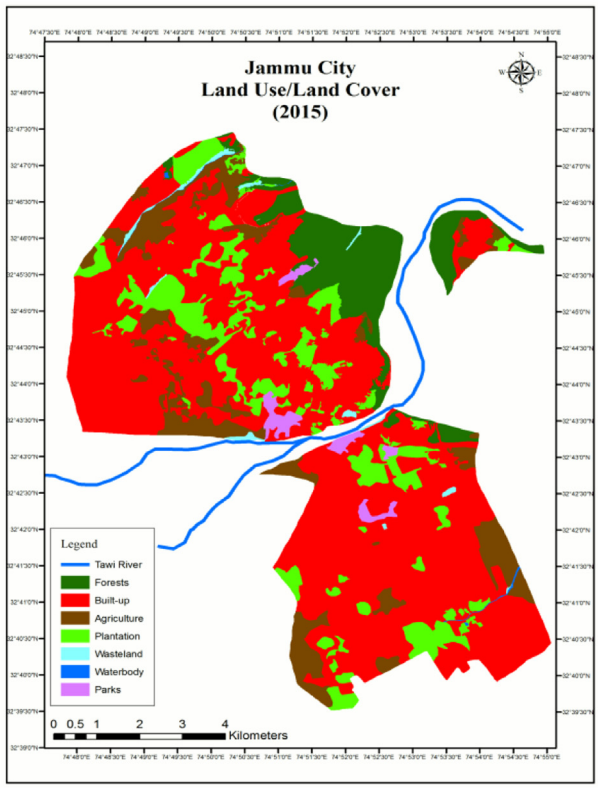
4.2.2. Slope map

The slope map clearly indicates that the southern Jammu city has gentle slope of less than 3° (Fig. 4c). The slope increases from plain south-west to undulating north-east part of the city. The north-eastern part of the city bears very steep slope. It includes the forest area and the wards lying in this zone are Janipur West, Janipur Central, Keran-I, Keran-II, Ustad Mohalla, New Plot etc.



Source: SRTM DEM 30m Resolution, 2012

a



Source: *Landsat-8 OLI (Operational Land Imagar-2015)*

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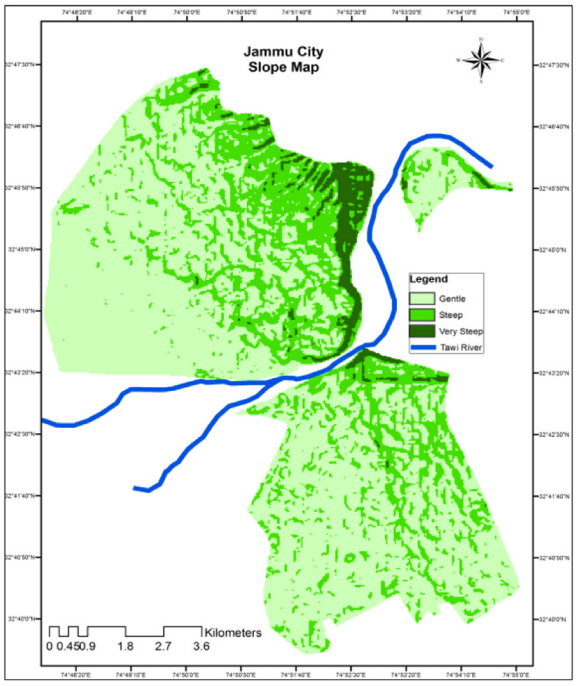

Source: SRTM DEM 30m Resolution, 2012

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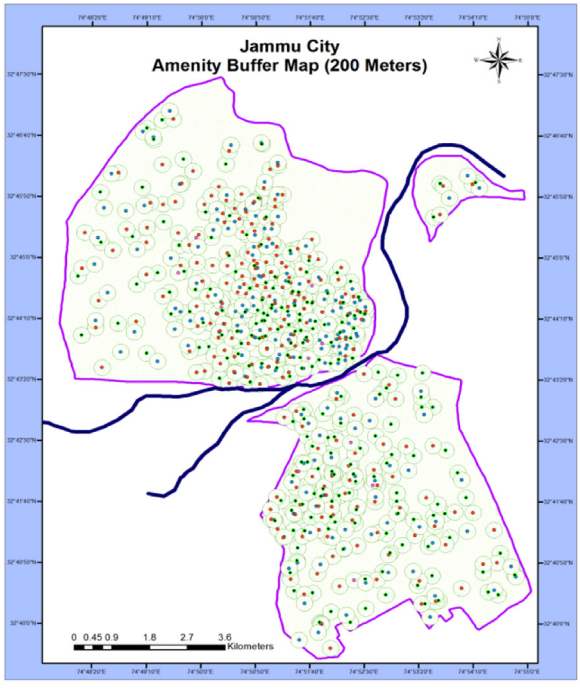

Source: Compiled from various sources of data Jammu, 2015

d

Fig. 4. (a-d): Various map layers for suitability analysis.

Table 5
Importance Matrix for Suitability Analysis.

	V.S	S	G	H	M	L	Ag	B	F	Pr	Wl	Pl	W	Ef	W.S	W.I
V.S	**1.00**	7.00	9.00	3.00	7.00	9.00	5.00	1.00	4.00	2.00	9.00	6.00	1.00	1.00	**0.16**	**16.48**
S	0.14	**1.00**	1.29	0.43	1.00	1.29	0.71	0.14	0.57	0.29	1.29	0.86	0.14	0.14	**0.02**	**2.35**
G	0.11	0.78	**1.00**	0.33	0.78	1.00	0.56	0.11	0.44	0.22	1.00	0.67	0.11	0.11	**0.02**	**1.83**
H	0.33	2.33	3.00	**1.00**	2.33	3.00	1.67	0.33	1.33	0.67	3.00	2.00	0.33	0.33	**0.05**	**5.49**
M	0.14	1.00	1.29	0.43	**1.00**	1.29	0.71	0.14	0.57	0.29	1.29	0.86	0.14	0.14	**0.02**	**2.35**
L	0.11	0.78	1.00	0.33	0.78	**100**	0.56	0.11	0.44	0.22	1.00	0.67	0.11	0.11	**0.02**	**1.83**
Ag	0.20	1.40	1.80	0.60	1.40	1.80	**1.00**	0.20	0.80	0.40	1.80	1.20	0.20	0.20	**0.03**	**3.30**
B	1.00	7.00	9.00	3.00	7.00	9.00	5.00	**1.00**	4.00	2.00	9.00	6.00	1.00	1.00	**0.16**	**16.48**
F	0.25	1.75	2.25	0.75	1.75	2.25	1.25	0.25	**1.00**	0.50	2.25	1.50	0.25	0.25	**0.04**	**4.12**
Pr	0.50	3.50	4.50	1.50	3.50	4.50	2.50	0.50	2.00	**1.00**	4.50	3.00	0.50	0.50	**0.08**	**8.24**
Wl	0.11	0.78	1.00	0.33	0.78	1.00	0.56	0.11	0.44	0.22	**1.00**	0.67	0.11	0.11	**0.02**	**1.83**
Pl	0.17	1.17	1.50	0.50	1.17	1.50	0.83	0.17	0.67	0.33	1.50	**1.00**	0.17	0.17	**0.03**	**2.75**
W	1.00	7.00	9.00	3.00	7.00	9.00	5.00	1.00	4.00	2.00	9.00	6.00	**1.00**	1.00	**0.16**	**16.48**
Ef	1.00	7.00	9.00	3.00	7.00	9.00	5.00	1.00	4.00	2.00	9.00	6.00	1.00	**1.00**	**0.16**	**16.48**
	6.07	**42.48**	**54.62**	**18.21**	**42.48**	**54.62**	**30.35**	**6.07**	**24.28**	**12.14**	**54.62**	**36.41**	**6.07**	**6.07**	**1.00**	**99.99**

V.S – very steep slope; S – steep slope; G – gentle slope; H – high altitude; M – medium altitude; L – low altitude; Ag – agriculture; B – built up; F – forest; Pr – parks; Wl – wasteland; Pl – plantation; W – water body; Ef – existing facilities

4.2.3. Altitude map

The altitude map (Fig. 4a) shows that Jammu city is located at an altitude varying between 200–600 m above mean sea level. Almost 33 percent area of the city posses 200 m altitude. The city has been divided into four altitude zones and the altitude increases from south-west to north-east in a terraced manner. The northern part of the city is located on siwaliks, therefore has high altitude; while as the southern part of the city is a plain area.

4.2.4. Existing amenity buffer map

The buffer map of 200 m around existing amenities (Fig. 4d) depicts that the core wards of the city have adequate existing amenities. The map clearly shows that the peripheral wards lack this amenity. The north-western and south-eastern wards of the city in general lack educational amenity. The wards lacking the amenity are Chenni-Himmat, Sainik colony-I, Keran-I, Pratap Paloura, Lower Muthi, Upper Muthi etc.

4.2.5. Integrated analysis for urban suitability

As per the methodology of determination of suitability analysis, weightage is given to physical parameters, by comparing each parameter with respect to the other parameter. The weightage assigned for all the parameters according to Saaty's scale are shown below in Table 5. Finally all the map layers were combined in a GIS environment to prepare the final urban suitability model based on weighted index model. The urban land use suitability map has been grouped into three categories namely high suitable, medium suitable and low suitable. The urban suitability map is shown in Fig. 5.

The Fig. 5 exhibits since Jammu city has terraced shape as altitude increases from south-west to north-east. This altitude factor exerted influence on the establishment of urban amenities in Jammu city. The old city wards have adequate urban amenities as compared to peripheral wards; therefore peripheral wards in general show medium to high level of suitability for establishing urban amenities. The peripheral wards in both north-west and south-west city though having favourable conditions like gentle slope, low altitude etc. but lack adequate urban amenities on account of being newer in history. These wards are the result of urban sprawl of the city; hence have short history than the old city wards. The municipal wards lying on the north-eastern and south-eastern parts of the city exhibit low suitability on account of several factors like land use, altitude, slope, existing amenities etc. These wards have more area under built up followed by plantation and agriculture. Moreover, these wards have high altitude and steep slope. The wards showing high suitability are Palour top, Top-sherkahania, Gole, Talab tillo south, Keran –II, Chek chengarwan, Sidhra, Gangyal-I, Digiana etc. followed by some old city wards, *viz,* Chennirama, Chandnagar, Pratapgarh, Subashnagar, Ambphalla etc. The core wards of the city like Gujjarnagar, Talab-khatikan, Jullaki mohalla, Panjthirthi, Paccadanga, Bahu west, Gandhinagar North, Chenni biza, Trikuta nagar etc. exhibit low suitability on account of having adequate amenities.

4.3. Suggestions

- More and more civic amenity establishments should be offered to people living far from the city centers and in the newly developed areas under sprawl process.
- The planning body for both Srinagar Metropolitan area and Jammu Metropolitan area should fill the existing gaps in the provision of amenities and in future must keep pace with the urban expansion in both time and space.
- Decentralization of some higher order functions must take place as otherwise this leads to problems like traffic congestion, traffic jams, and pollution etc. in the core of the cities.
- A comprehensive urban policy should be framed for both the urban centers restricting the unprecedented growth of the cities in future.

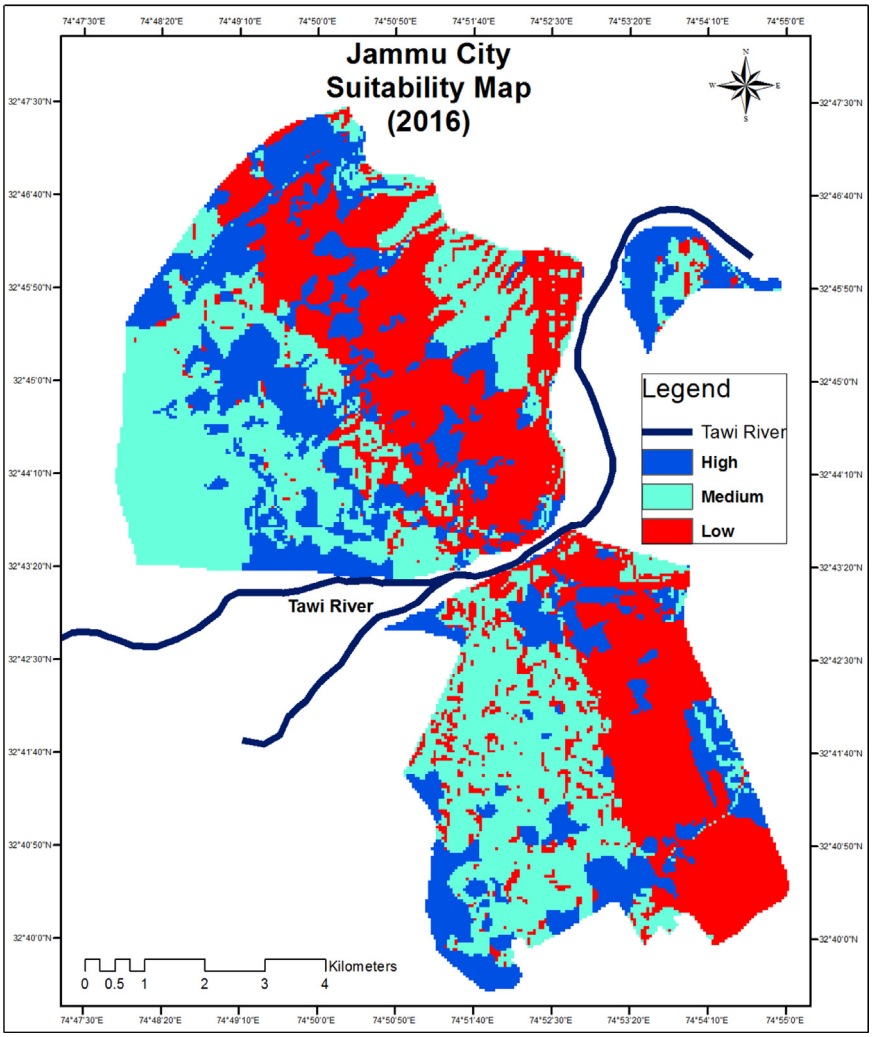

Fig. 5. Suitability map for location of amenities.

5. Conclusion

The study on the provision of public facilities in Srinagar and Jammu cities indicate that urban amenities are not evenly distributed among different wards of the city. The suitability analysis of urban amenities in Srinagar city depicted that since the core wards of the city have adequate urban amenities as compared to peripheral wards, therefore peripheral wards in general show medium level of suitability for establishing urban amenities. These peripheral wards though have inadequate urban amenities but due to several factors like high altitude, steep slope, inaccessibility etc. these wards fall in medium level of suitability. The municipal wards lying between core and peripheral wards depict high suitability for the provision of urban amenities because of favourable slope, altitude, accessibility etc. plus lack of existing urban amenities. In Jammu urban center it revealed that since Jammu city has terraced shape as altitude increases from south-west to north-east. This altitude factor exerted influence on the establishment of urban amenities in Jammu city. The old city wards have adequate urban amenities as compared to peripheral wards; therefore peripheral wards in general show medium to high level of suitability for establishing urban amenities. The peripheral wards in both north-west and south-west city though having favourable conditions like gentle slope, low altitude etc. but lack adequate urban amenities on account of being newer in history. These wards are the result of urban sprawl of the city; hence have short history than the old city wards. The municipal wards lying on the north-eastern and south-eastern parts of the city exhibit low suitability on account of several factors like land use, altitude, slope, existing amenities etc. These wards have more area under built up followed by plantation and agriculture. Moreover, these wards have high altitude and steep slope. The results of the research work are providing valuable information for the urban extension for policy and decision makers. More research work needs to be done in the priority areas of urban service delivery in both the urban centers for better results. The priority research areas which have not been touched so far are geographical factors affecting surface road network, rail transport, viability of metro system development, decongestion of core areas, planned residential establishments etc.

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