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Effect of Recent Land Cover Dynamics on Different Species of Kanpur Metropolis in Ganga-Yamuna Doab region of India

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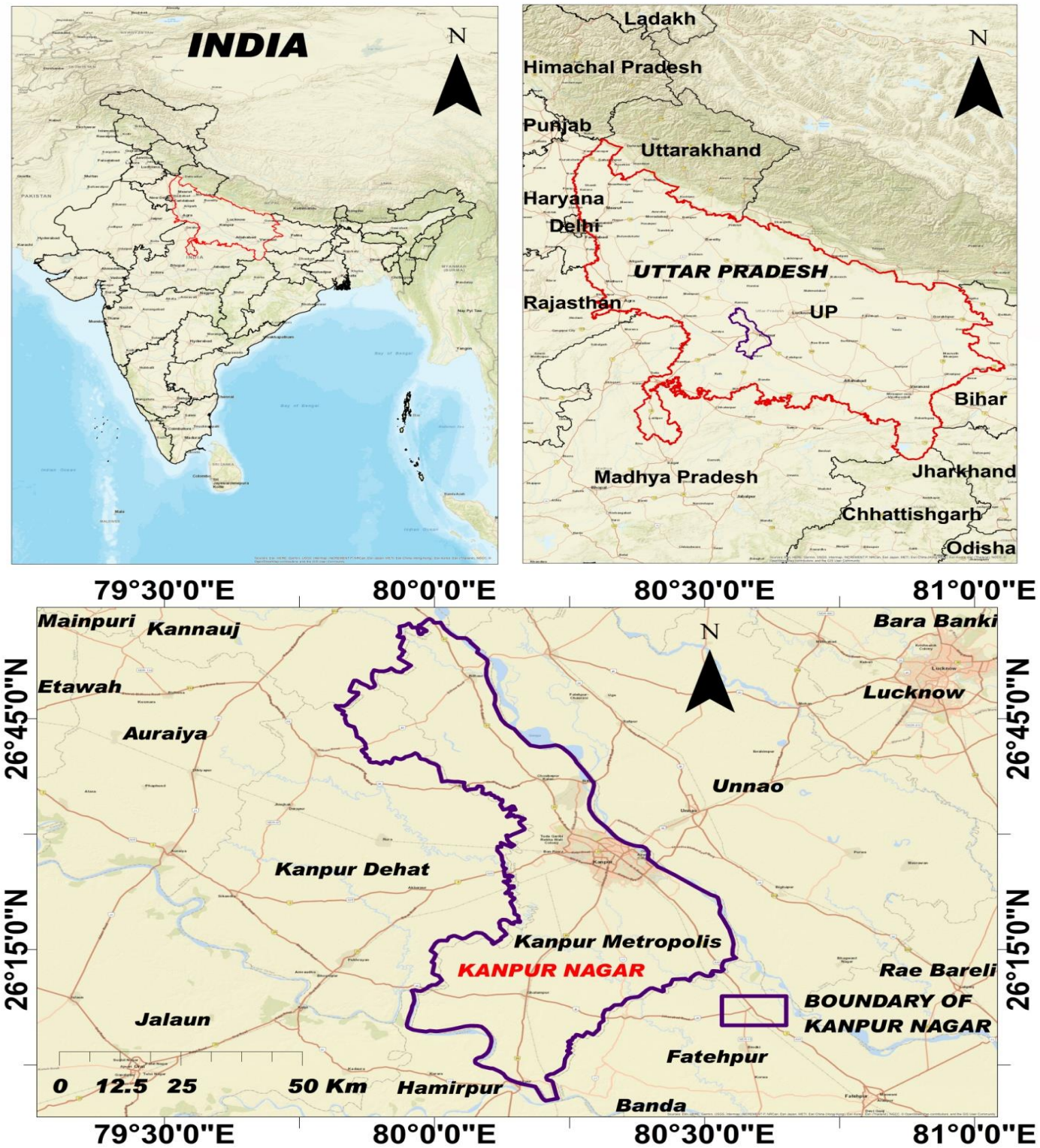
Abstract: As due to migration, now-a-days the population of cities is increasing due to which urbanization is taking place which in turn changing the Land forms of this region drastically and which in turn effect Land Cover Indices and the change in land cover indices effects lives of different species. The current study is based on changing pattern of land cover indices such as MNDWI, NDBaI, NDBI, NDVI and SAVI and it's effect on different species of Kanpur Metropolis which is located on the bank of the river Ganga and occupies the area of Kanpur Nagar District with the Yamuna River serving as the region's southern boundary due to it's urban sprawl. As the land cover dynamics effects the human health and ecological evolution. The study is based on calculation of Land Cover Indices and retrieval of Discomfort Index and Urban Thermal Field Variation Index carried out by using Landsat 5, 7 & 8 data for the years 1991, 2001, 2011 & 2021 having projection WGS_1984_UTM_Zone_44N with 30m spatial and thermal resolution using ArcGIS 10.8 The study shows the effect of land cover indices on human health and ecological evolution of Kanpur Metropolis by Linear trend analysis taking 168 points into consideration. The study also gives some idea about to make development plans for Ganga-Yamuna Doab region of India.

Keywords- **Land Cover Indices, Human Health, Ecological Evolution**

Introduction: Now-a-days, large portion of Earth's surface is altering due to increasing demand from natural sources by which the conversion and management of Earth's surface is getting difficult (Vitousek, 1997; Foley et al., 2005; Rahman et al., 2012; Song et al. 2018). The alteration of Earth's surface gives the rise to the concept of Land Use Land Cover (LULC) change. This change of LULC can be described by the Dynamics of Land Cover Indices (MMH Seyam et al. 2023). As the land cover indices gives the information of different types of land surfaces such as Vegetation Cover, Water Body, Barren Land, Shurb Land and Built-up areas, it becomes easy to detect and to measure these features through different spectral bands of satellite. And these satellite bands gives the information about land cover features based on Coarse to sub-pixel classification (Y Xu et al. 2017). As these land cover indices are based on different types of land cover types so it also includes the information of thermal properties of these land types (J. Zhao et al. 2020). As these land cover interacts with their emissivity processes (M. Jin et al. 2006; S. Pal. et al. 2017) it gives information about the total temperature of land surfaces which is commonly known as Land Surface Temperature (O. Acharya et al. 2022). In this way these land cover indices gives some relations with Urban Heat (M. Bokaie et al. 2016; M. Naserikia et al. 2022). However Urban Heat effects the human health and ecological evolution (Y. Dai et al. 2022). The heat intensity indicates presence of land indices present there. In that case the land cover indices indirectly effects the human health and ecological evolution. So, by knowing the trend analysis between different land indices such as MNDWI, NDBaI, NDBI, NDVI and SAVI and Discomfort Index and Urban Thermal Field Variance Index (A.Y. Ghouri et al. 2022) we can get the effect of land cover indices on dispersal ability of species (Y. Melero et al. 2020) and human health. These changes of Discomfort Index and Urban Thermal Field Variance Index with alteration of land cover indices forced to rethink and for to make redevelopment plans for urban areas (F. Renald et al. 2019). In view of these things the authors of this paper rethink about to know of the trend analysis between different land cover indices and Discomfort Index and Urban Thermal Field Variance Index. The all work is carried out by Earth Observation (EO) datasets and a quantitative approach based on geospatial technology (GT) (Q. Zhao et al. 2022). The linear trend analysis is carried out by taking 168 points into consideration for the entire region of Kanpur Metropolis in Ganga-Yamuna Doab region of India and the value of correlation is carried out by putting the equation and R^2 for non-parametric statistical approach (H. Gandhi et al. 2023; Qi et al. 2023).



2. Materials and Methods

2.1 Area of Study:

In the "Survey of India's" Toposheet Nos. 54N and 63B, the study area Kanpur Nagar (Fig. 1) is situated over north-central India in the middle of the state of Uttar Pradesh between latitudes 25°55'N to 27°N and longitude 79°30'E to 80°35'E. It is one of the Indian cities with a population greater than 4.5 million and is bordered on the north by the Ganga River and on the south by the Pandu River (Yamuna). It is the eleventh most populous urban city in India (according to 2011 census).

The districts of Kanuuaj and Hardoi, Unnao in the east, Fatehpur and Hamirpur in the south, and Kanpur Dehat in the west form its northern, eastern, southern, and western boundaries. It is separated from the districts of Kanpur Dehat and Fatehpur in the west and south, respectively, by the Pandu River, and from the district of Unnao in the east by the holy Ganga River, which acts as a natural barrier. Kanpur Nagar district comes under the "Ministry of Housing and Urban Affairs, Government of India (GoI)". It has a total

geographic area of 3180 sq. km, and the city's total area is 403 km^2. The river Ganga and river Yamuna forms the study area's north-east and south-west boundaries, respectively, and develop the fertile agricultural hinterland of Ganga and Yamuna Doab. It has a population of 4.58 million and a population density of 6850 people per km^2 (District Census Handbook, 2011), The study area has an average elevation of 125 meters above mean sea level and is located on a nearly level plain with a few minor undulations, with the master slope running from the northwest to the south-east while river Ganga and river Yamuna makes district's climate sub-humid and it is characterized by hot summers and general dryness save for the south-west monsoon, having an average annual rainfall of 821.9 mm. The average monthly maximum temperature in the district is 32.2°C, while the average monthly minimum temperature is 19.5°C. The main sedimentary constituents of the soil are clay, silt, gravel, and sands of various grades. The district also enjoys strong administration and has good range of all facilities for its people.

2.2 Data:

From the US Geological Survey's website, https://earthexplorer.usgs.gov/, path 144 and rows 041 and 042 of Landsat5, Landsat7, and Landsat8 data are downloaded. The data are then mosaiced, and ArcMap 10.8 software is used to extract data for the region.

Specifics of the used satellite images

Satellite	Sensor	Acquisition date	Path and row	Spatial resolution	Thermal resolution	Cloud Cover
Landsat 5	TM	16 March 1991	144/041 & 144/042	30 m	120(30)m	<10%
Landsat 7	ETM+	03 March 2001	144/041 & 144/042	30 m	60(30)m	<10%
Landsat 5	TM	07 March 2011	144/041 & 144/042	30 m	120(30)m	<10%
Landsat 8	OLI/TIRS	02 March 2021	144/041 & 144/042	30 m	100m	<10%

Table-1 Used Data

The retrieval of Discomfort Index and Urban Thermal Field Variance Index were carried out by using thermal bands of Landsat satellites land cover indices were extracted from satellite images of the Landsat series in this study, and the year-by-year values of Discomfort Index and Urban Thermal Field Variance Index were compared with the MNDWI, NDBaI, NDBI, NDVI, and SAVI indices. The process of Extracting the land cover indices and retrieval of Discomfort Index and Urban Thermal Field Variance Index is given below:

2.3.1 Land Cover Indices

The Normalized Difference Bareness Index (NDBaI) recognizes various types of bare areas, while the Modified Normalized Difference Water Index (MNDWI) is used to improve open water features. The Normalized Difference Vegetation Index (NDVI), which is used to measure vegetation greenness and is helpful in understanding vegetation density, Normalized Difference Built-up Index (NDBI) emphasizes artificially constructed built-up areas. In areas with little vegetative cover, the Soil Adjusted Vegetation Index (SAVI) is used to measure the impact of soil brightness.
Keeping this in view Zha et al., (2003)
proposed the mechanism to derive these indices and according to it, MNDWI, NDBaI, NDBI, NDVI, and SAVI indices can be derived from these formulas:

- MNDWI is equal to (Green – SWIR) / (Green + SWIR)

In the case of Landsat 5,7, MNDWI is equal to float (Band 2 - Band 5)/float (Band 2 + Band 5)
In the case of Landsat 8, MNDWI is equal to float (Band 3 - Band 6)/float (Band 3 + Band 6)

- NDBaI is equal to (SWIR - TIR)/ (SWIR - TIR)

In the case of Landsat 5,7, NDBaI is equal to float (Band 5 - Band 6)/float (Band 5 + Band 6)
In the case of Landsat 8, NDBaI is equal to float (Band 6 - Band 10)/float (Band 6 + Band 10)

- NDBI is equal to (SWIR – NIR) / (SWIR + NIR)

In the case of Landsat 5,7, NDBI is equal to float (Band 5 - Band 4)/float (Band 5 + Band 4)
In the case of Landsat 8, NDBI is equal to float (Band 6 - Band 5)/float (Band 6 + Band 5)

- NDVI is equal to (NIR – Red) / (NIR + Red)

In the case of Landsat 5,7, NDVI is equal to float (Band 4 - Band 3)/float (Band 4 + Band 3)
In the case of Landsat 8, NDVI is equal to float (Band 5 - Band 4)/float (Band 5 + Band 4)

- SAVI is equal to ((NIR - R) / (NIR + R + L)) * (1 + L)

In case of Landsat 5,7 SAVI is equal to float ((Band 4 – Band 3) / float (Band 4 + Band 3 + 0.5)) * (1.5).
In case of Landsat 8 SAVI is equal to float ((Band 5 – Band 4) / float (Band 5 + Band 4 + 0.5)) * (1.5).

The term "float" in the formulas above refers to floating-point, which is conceptually similar to scientific notation.

2.3.2 Discomfort Index Retrieval:

In 2020 Sobrino and Irakulis proposed that Discomfort Index can be used for the human restless conditions and it can be given as following empirical formula:

$$DI = LST - (0.55 - 0.0055\ RH)\ (LST - 14.5)$$

Since relative humidity depends on land surface emissivity, it can also be described by water vapor content (WVC), where DI stands for discomfort index, LST for land surface temperature, and RH for relative humidity.

2.3.3 Urban Thermal Field Variance Index Retrieval:

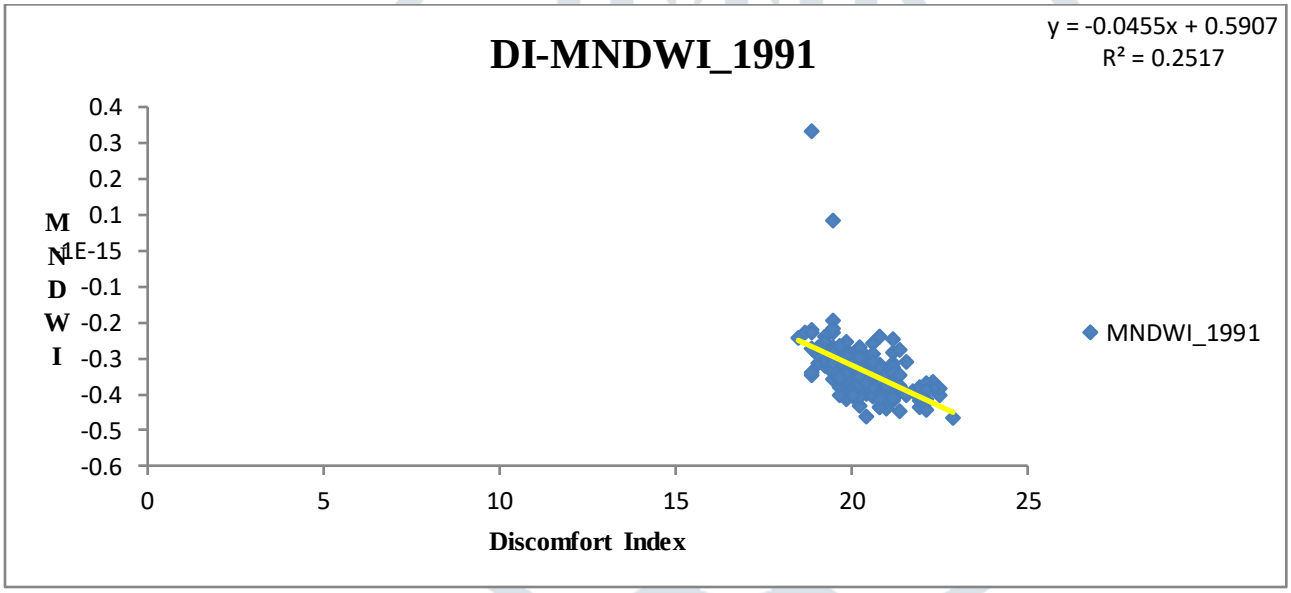
Zhang et al., (2006) and K. Singh et al., (2017) state that it can be given as:

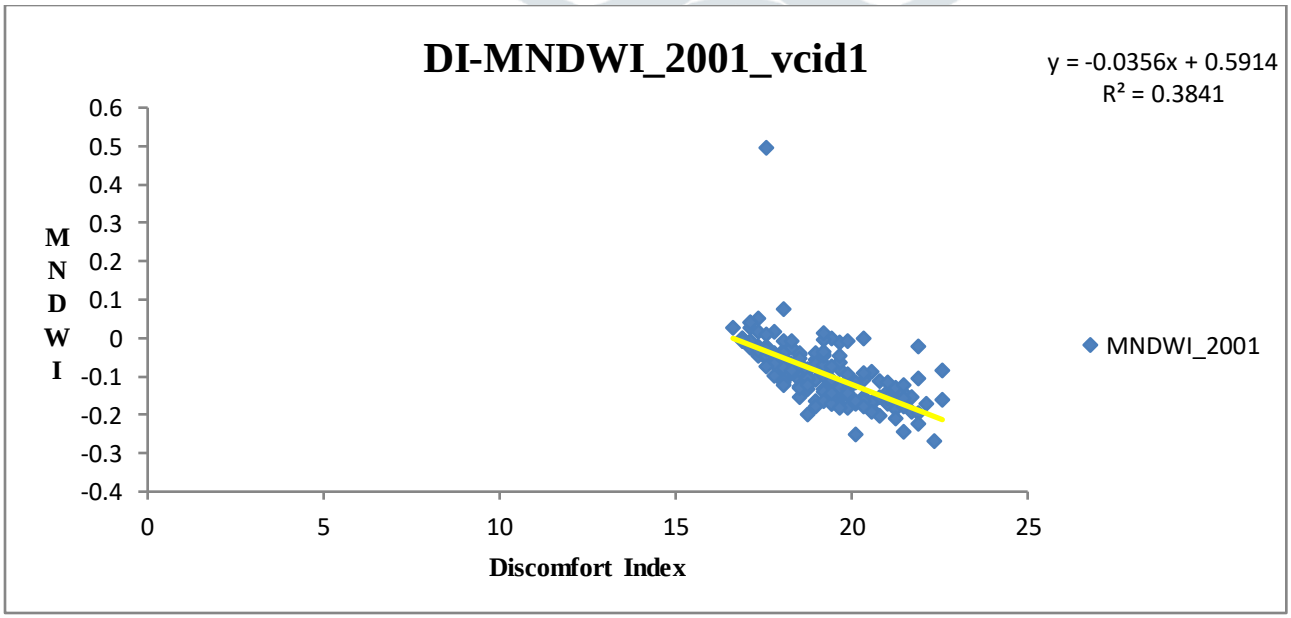
UTFVI is equal to $((T_s - T_{Mean}) / T_{Mean})$

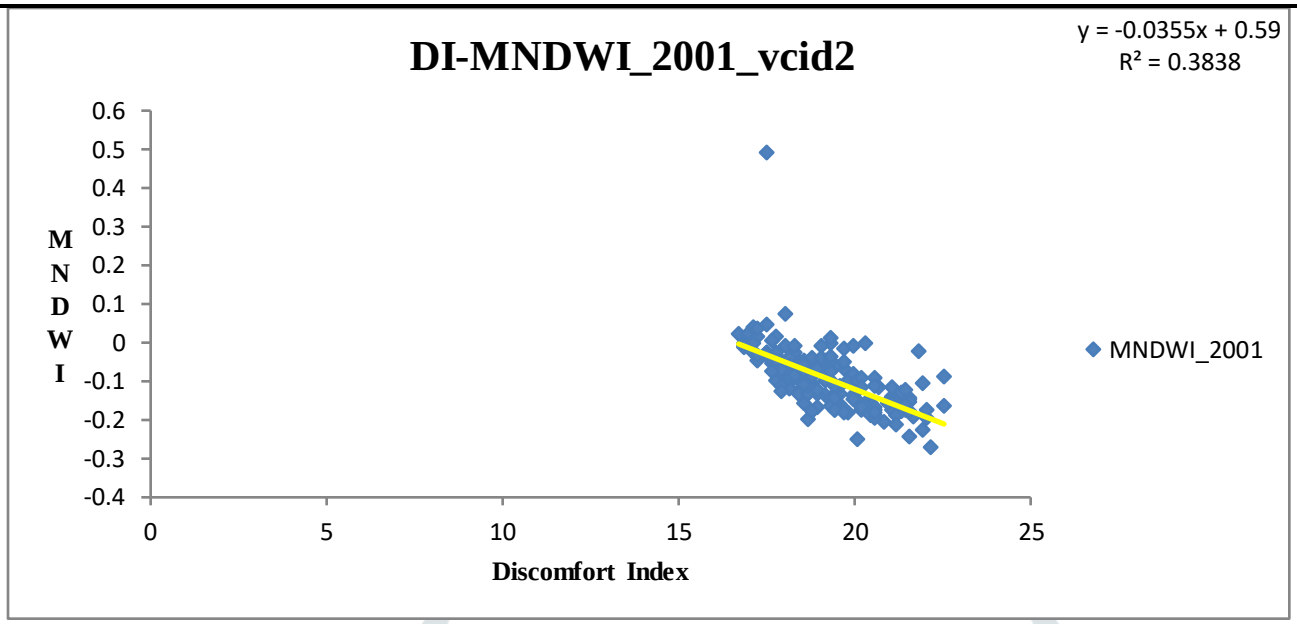
Where, T_S stands for land surface temperature and T_{Mean} for the region's mean LST.

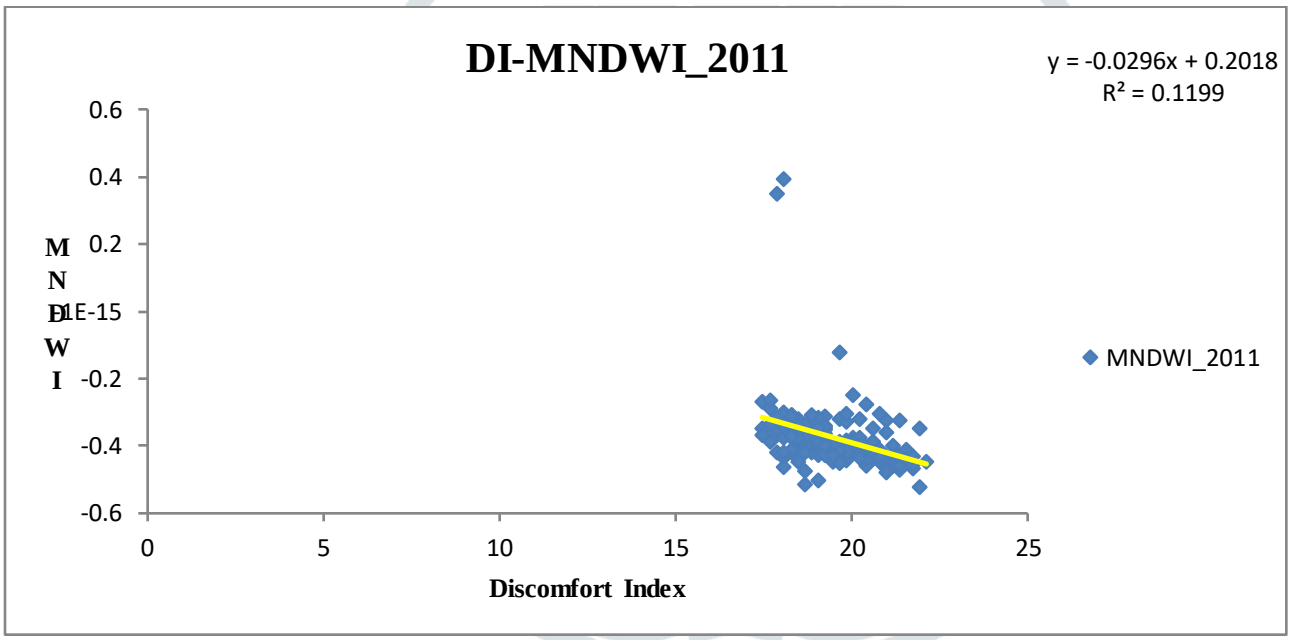
Result:

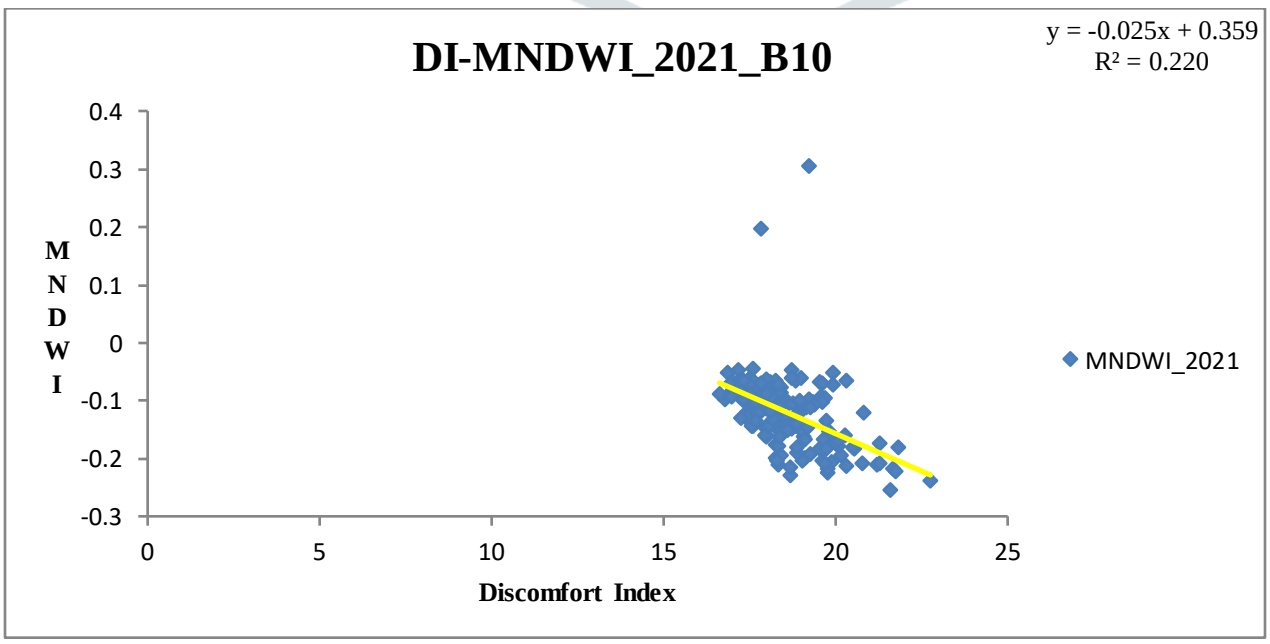
The relation between Discomfort Index and Modified Normalized Difference Water Index is given below:

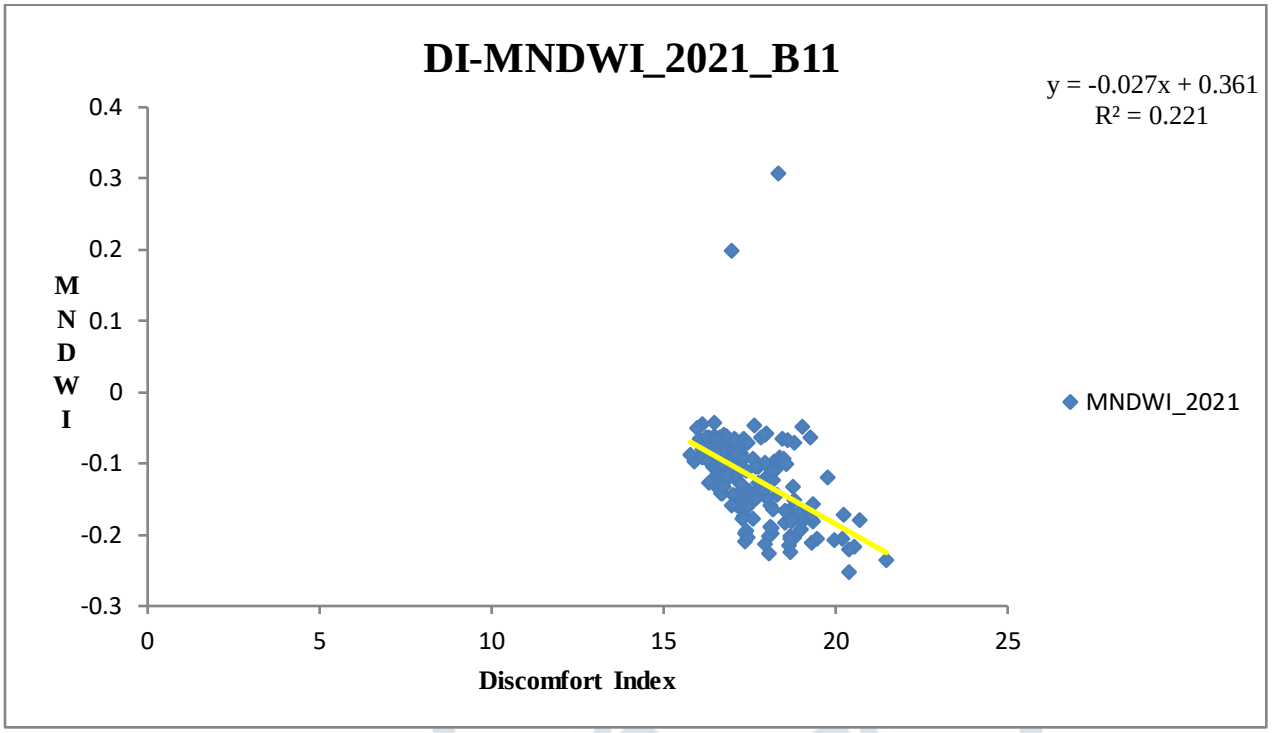




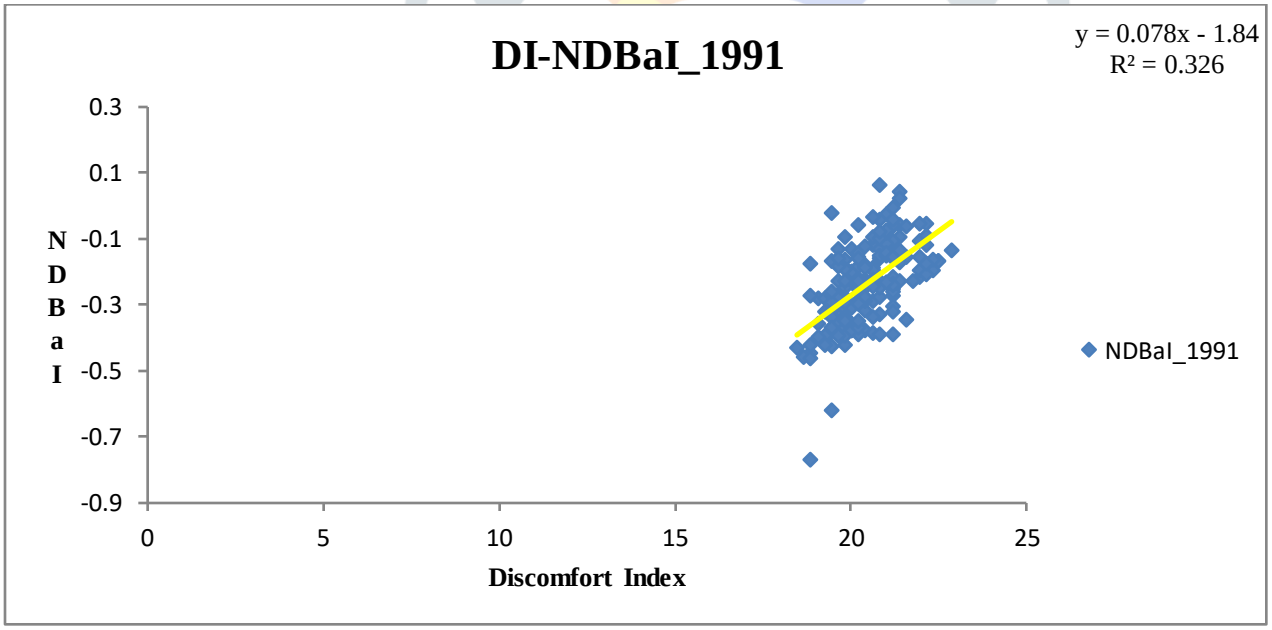

DI-MNDWI_2001_vcid2
y = -0.0355x + 0.59
R² = 0.3838
MNDWI
Discomfort Index
MNDWI_2001

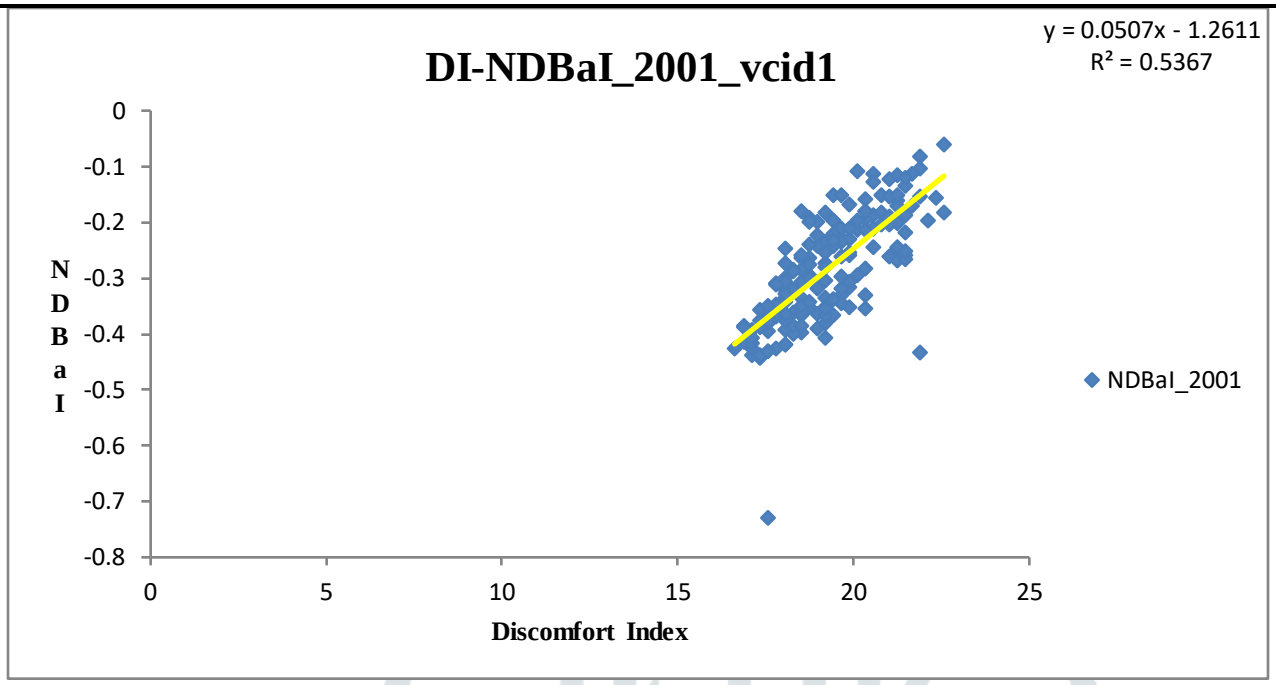

DI-MNDWI_2011
y = -0.0296x + 0.2018
R² = 0.1199
MNDWI
Discomfort Index
MNDWI_2011

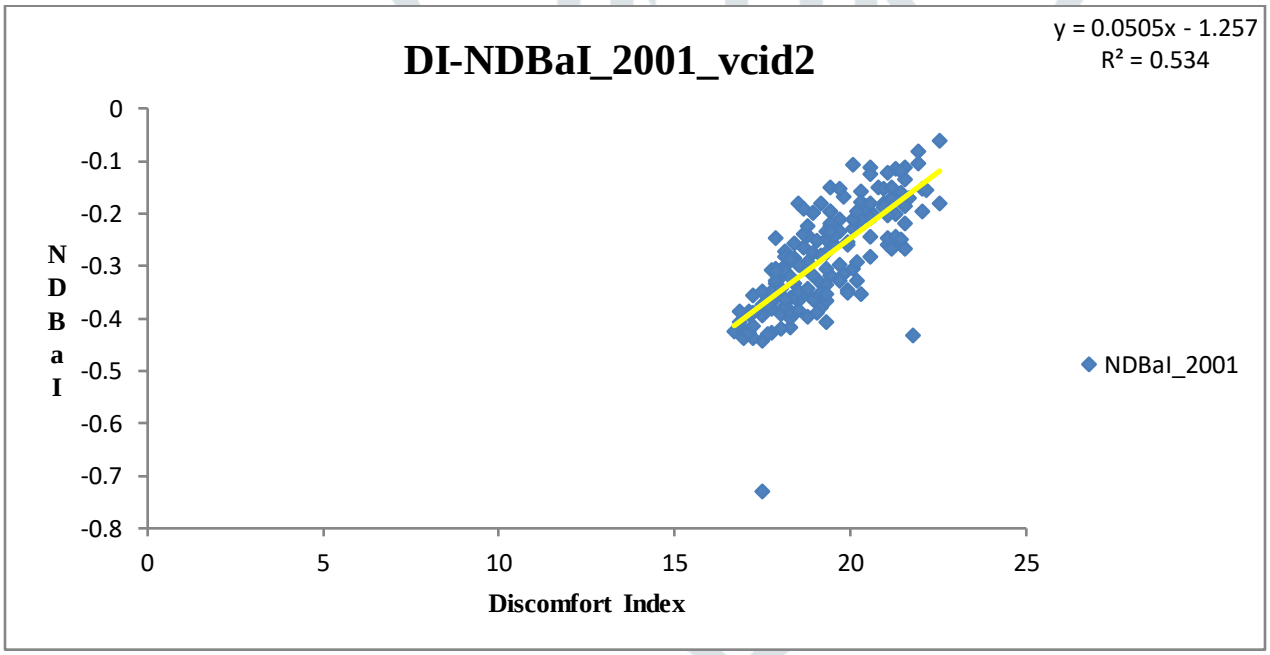

DI-MNDWI_2021_B10
y = -0.025x + 0.359
R² = 0.220
MNDWI
Discomfort Index
MNDWI_2021

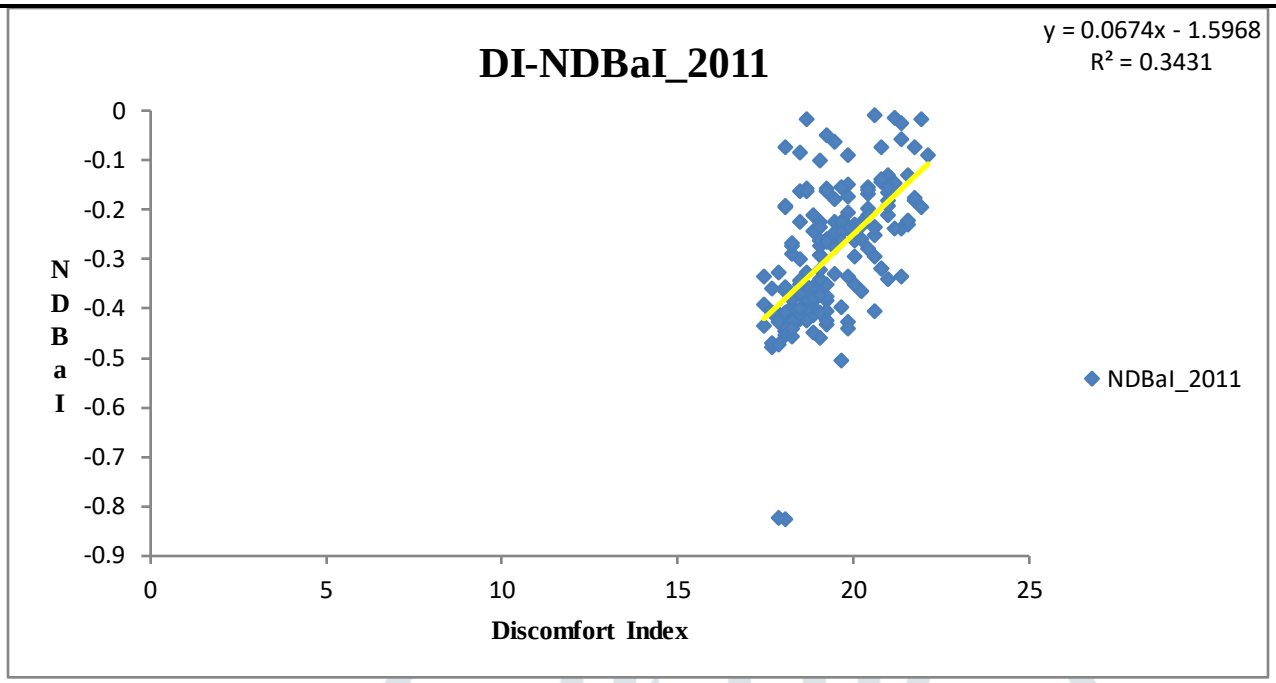


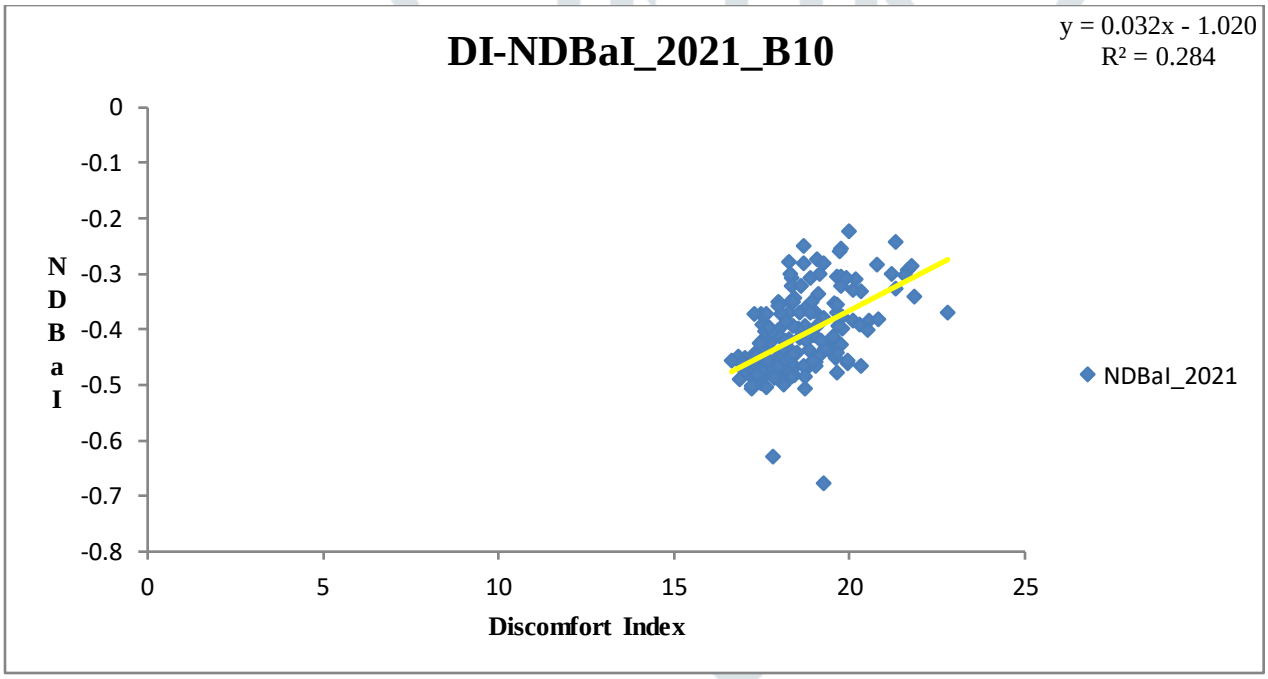
The relation between Discomfort Index and Normalized Difference Barren land Index is given below:

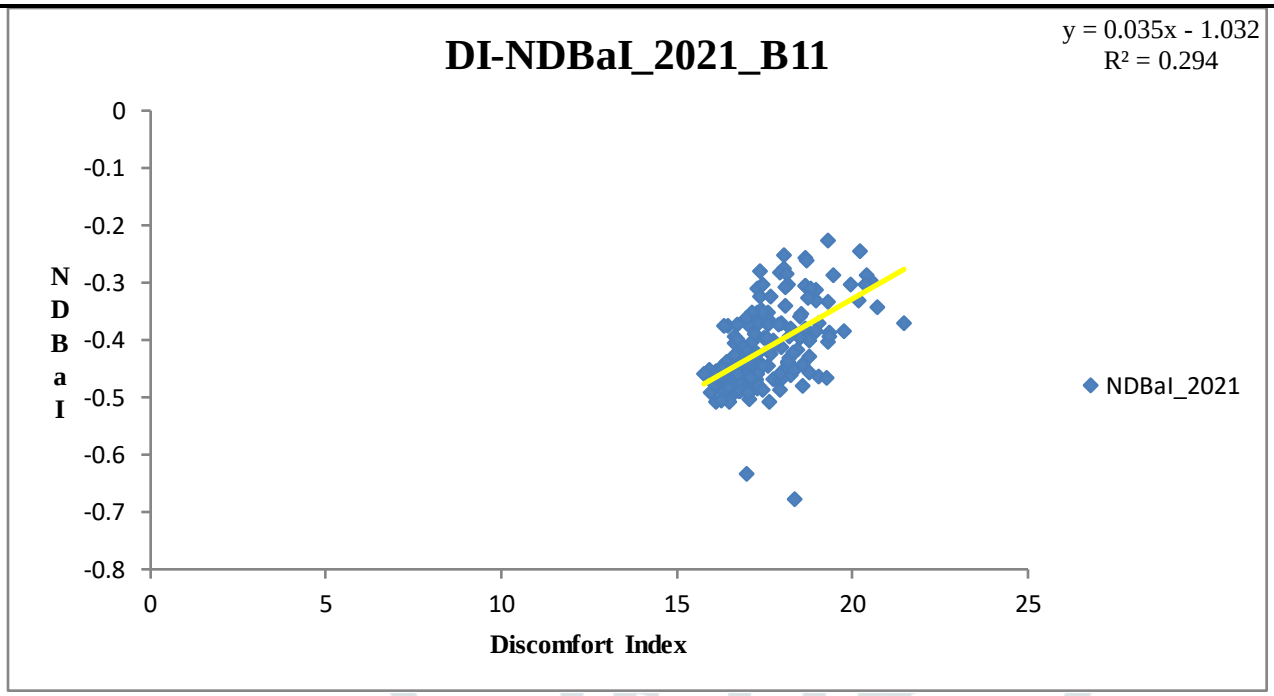



DI-NDBaI_2001_vcid1
y = 0.0507x - 1.2611
R² = 0.5367
NDBaI
Discomfort Index
NDBaI_2001
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
0
5
10
15
20
25

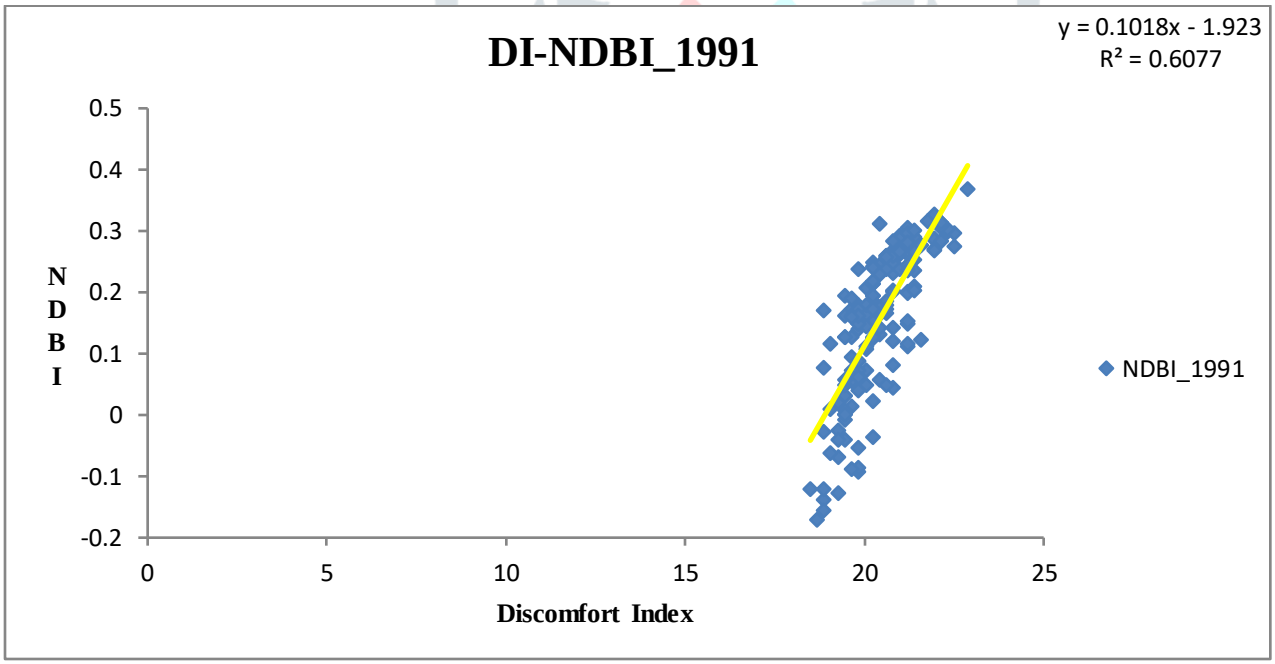

DI-NDBaI_2001_vcid2
y = 0.0505x - 1.257
R² = 0.534
NDBaI
Discomfort Index
NDBaI_2001
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
0
5
10
15
20
25

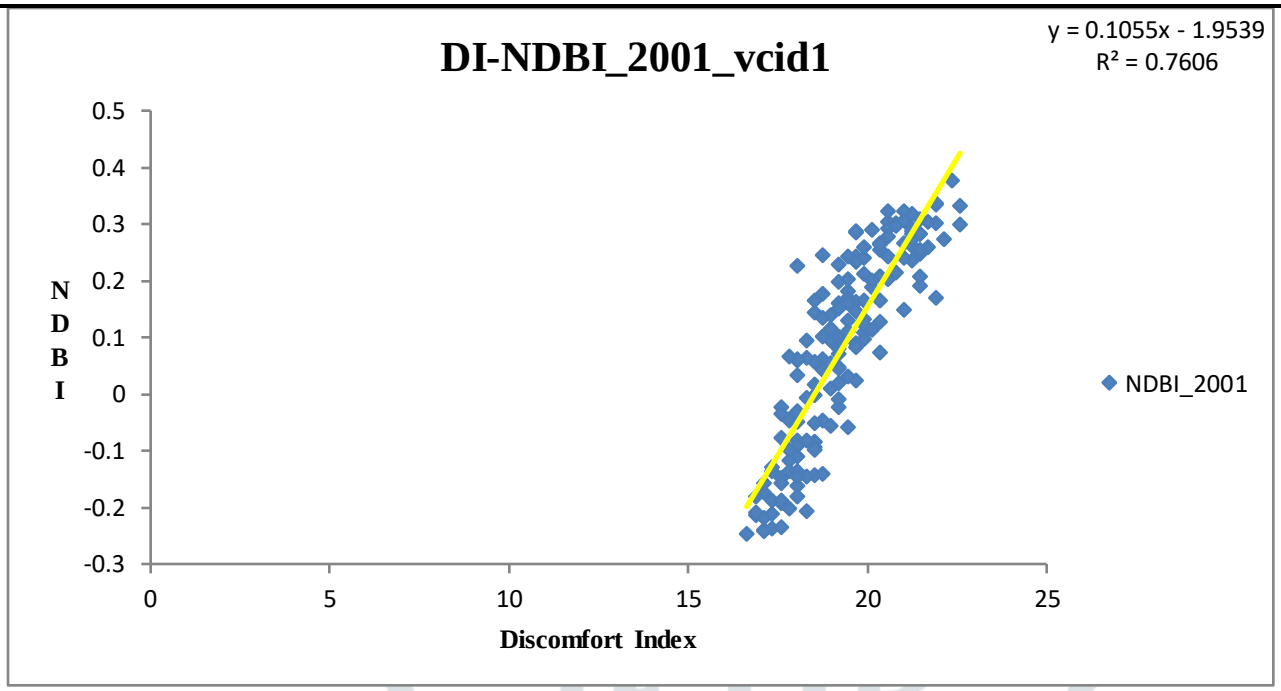

DI-NDBaI_2011
y = 0.0674x - 1.5968
R² = 0.3431
NDBaI
Discomfort Index
NDBaI_2011

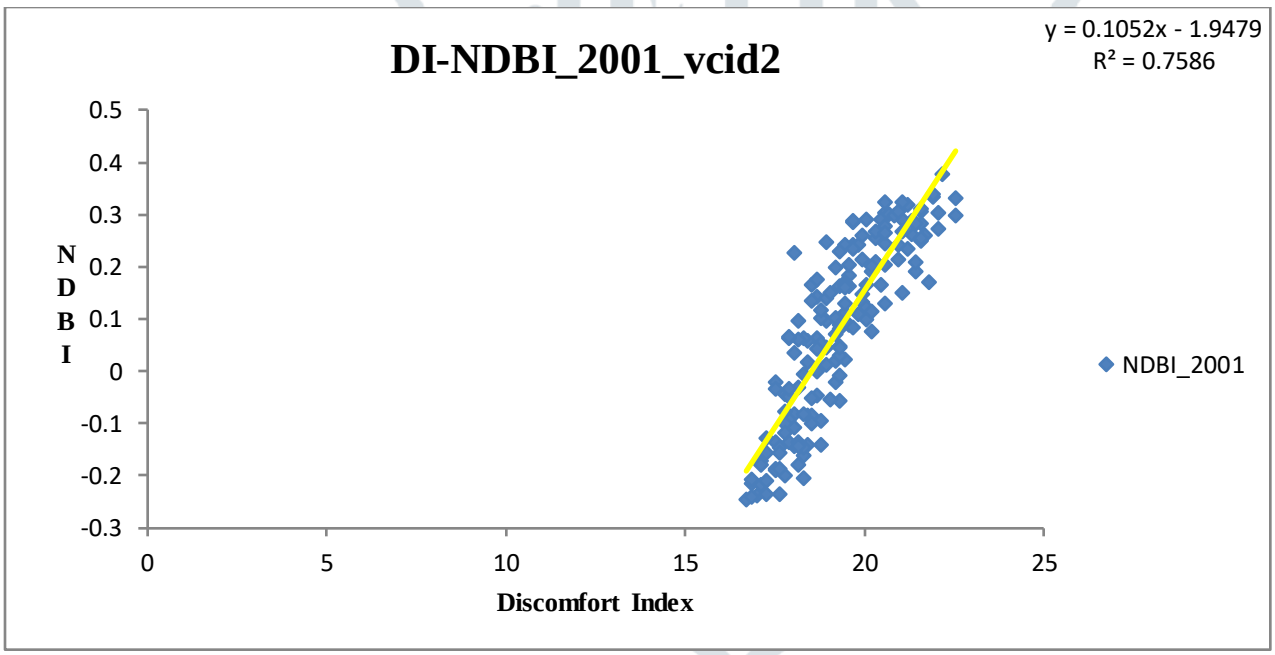

DI-NDBaI_2021_B10
y = 0.032x - 1.020
R² = 0.284
NDBaI
Discomfort Index
NDBaI_2021

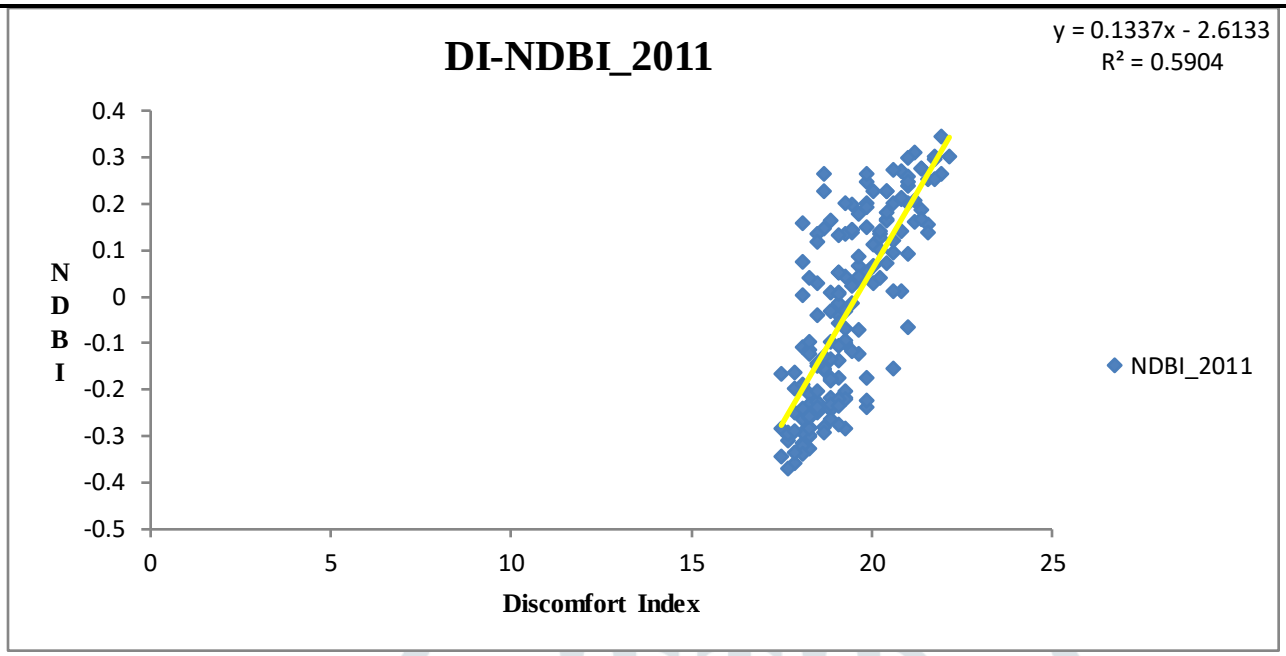


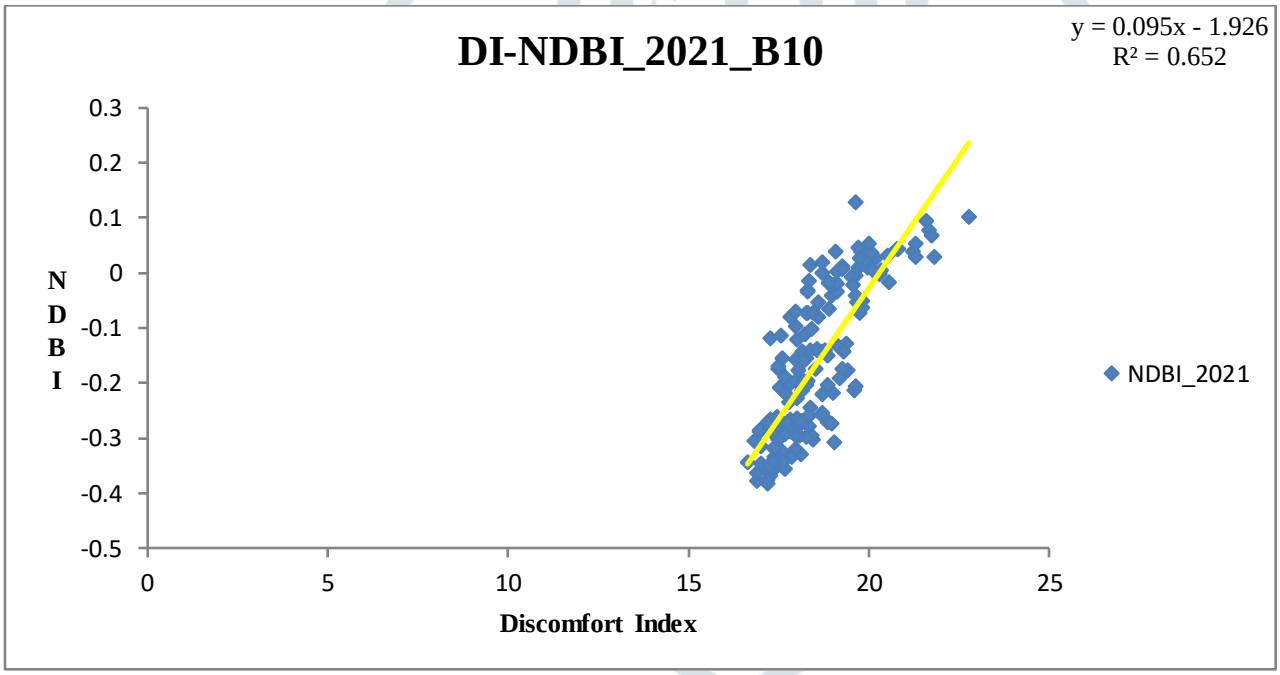
The relation between Discomfort Index and Normalized Difference Built-up Index is given below:

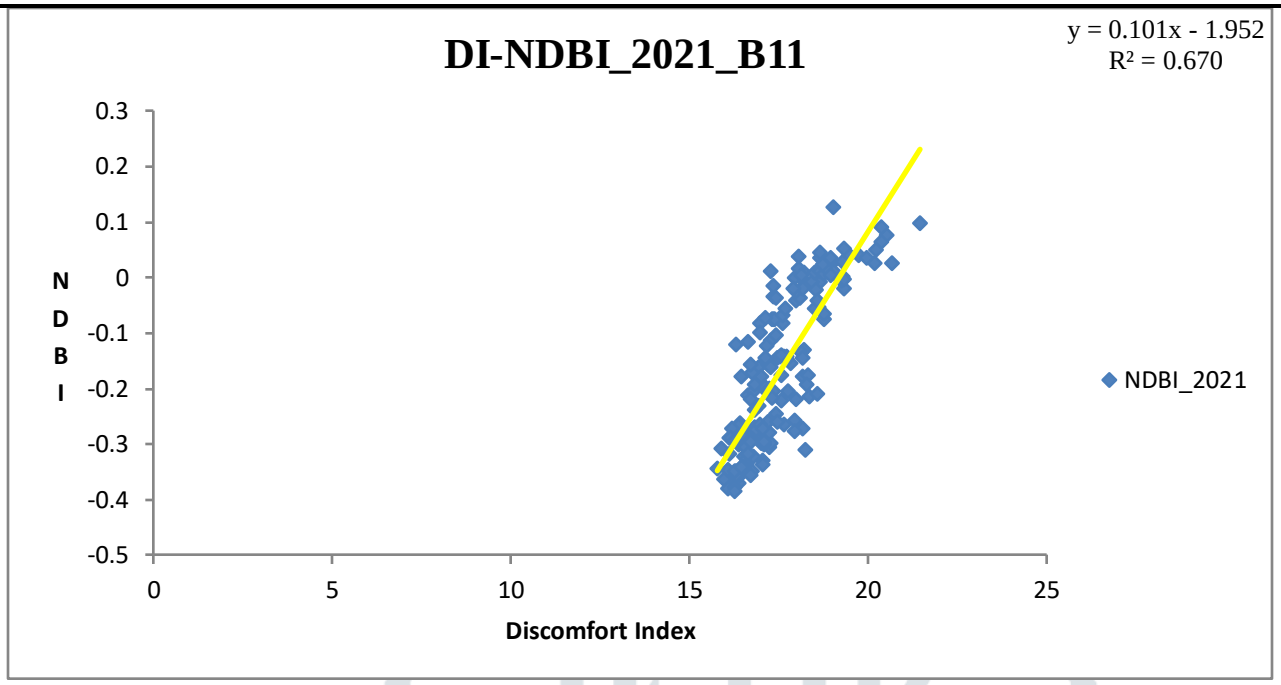



DI-NDBI_2001_vcid1
y = 0.1055x - 1.9539
R² = 0.7606
NDBI
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
0
5
10
15
20
25
Discomfort Index
NDBI_2001

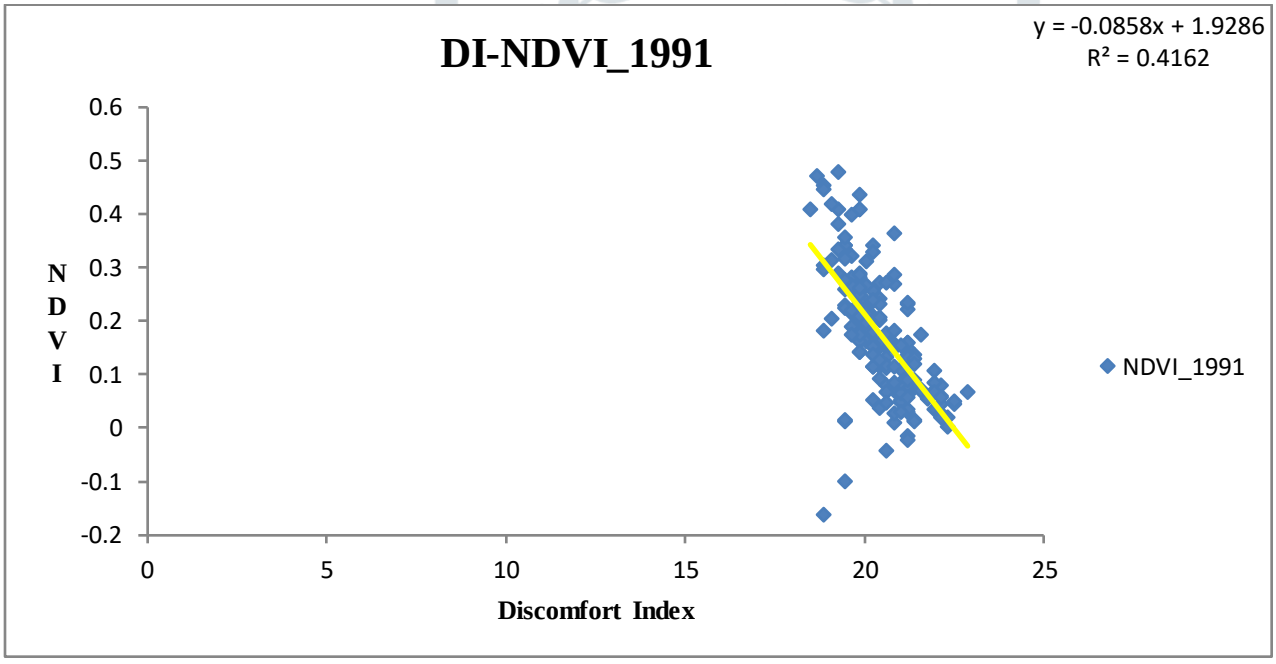

DI-NDBI_2001_vcid2
y = 0.1052x - 1.9479
R² = 0.7586
NDBI
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
0
5
10
15
20
25
Discomfort Index
NDBI_2001

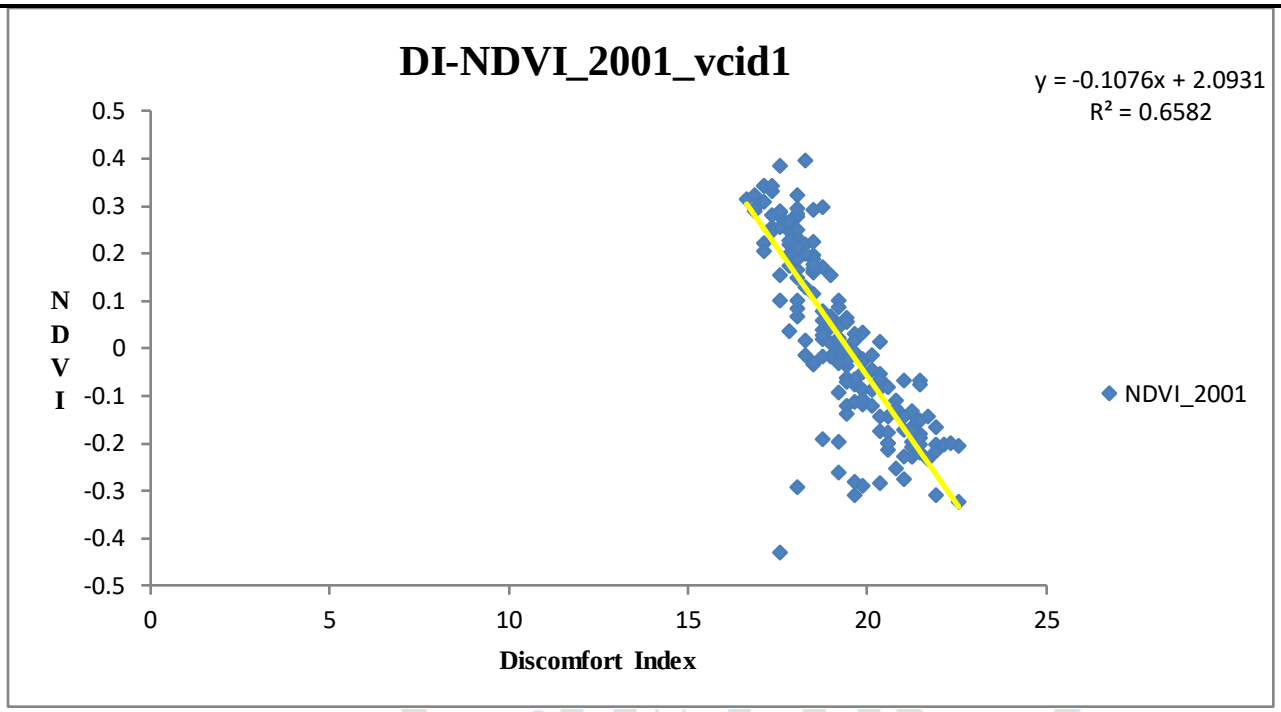

DI-NDBI_2011
y = 0.1337x - 2.6133
R² = 0.5904
NDBI
Discomfort Index
NDBI_2011

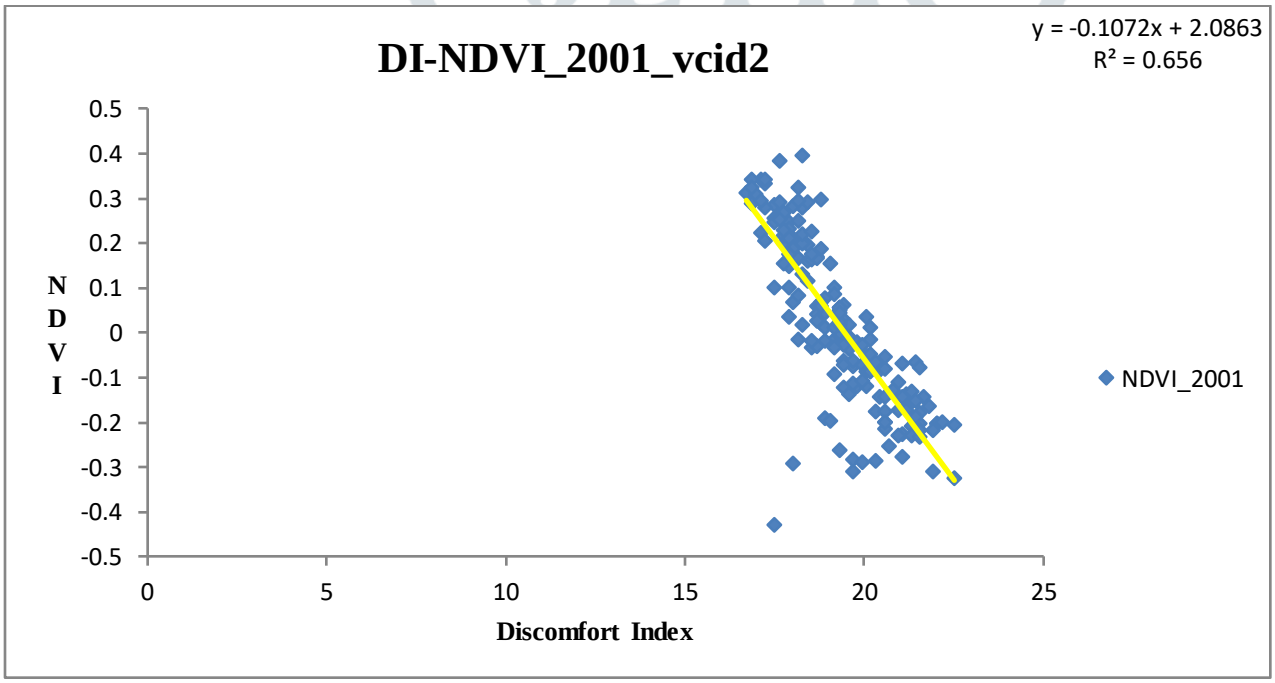

DI-NDBI_2021_B10
y = 0.095x - 1.926
R² = 0.652
NDBI
Discomfort Index
NDBI_2021

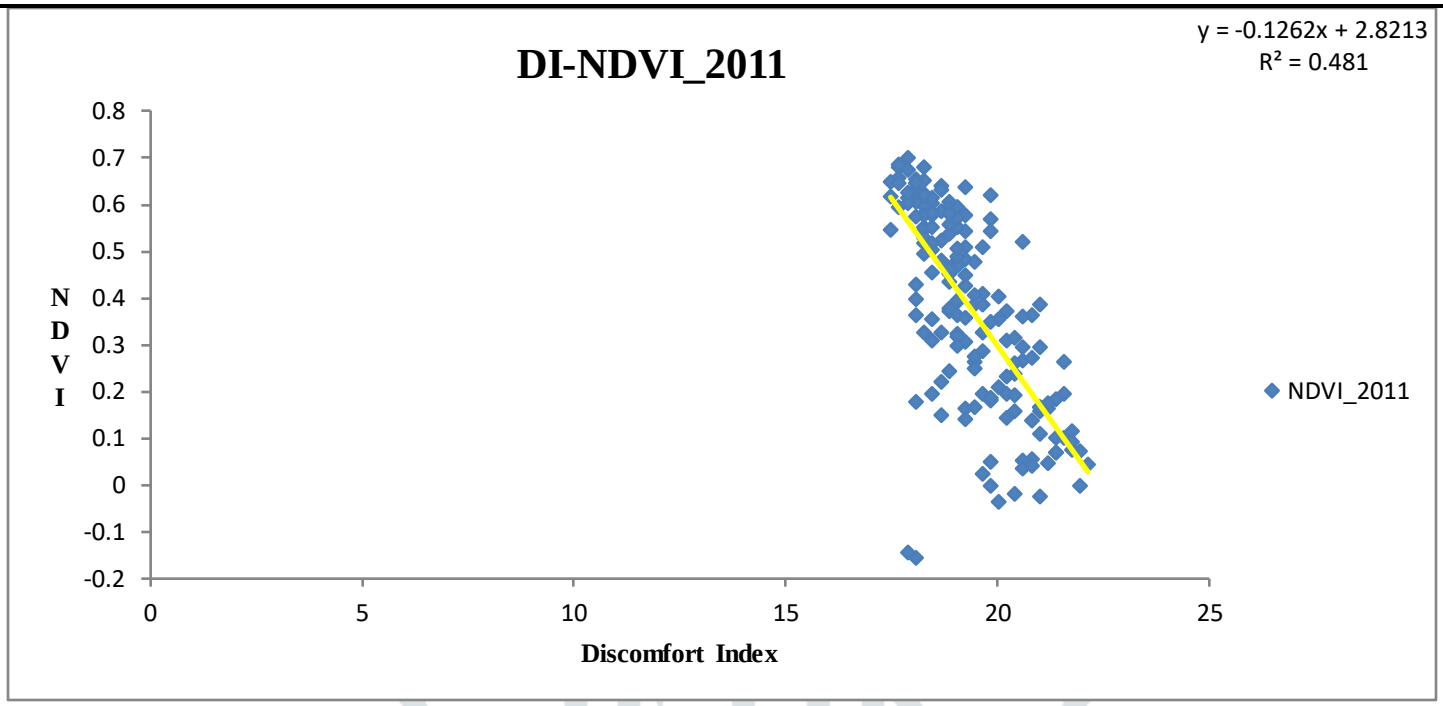


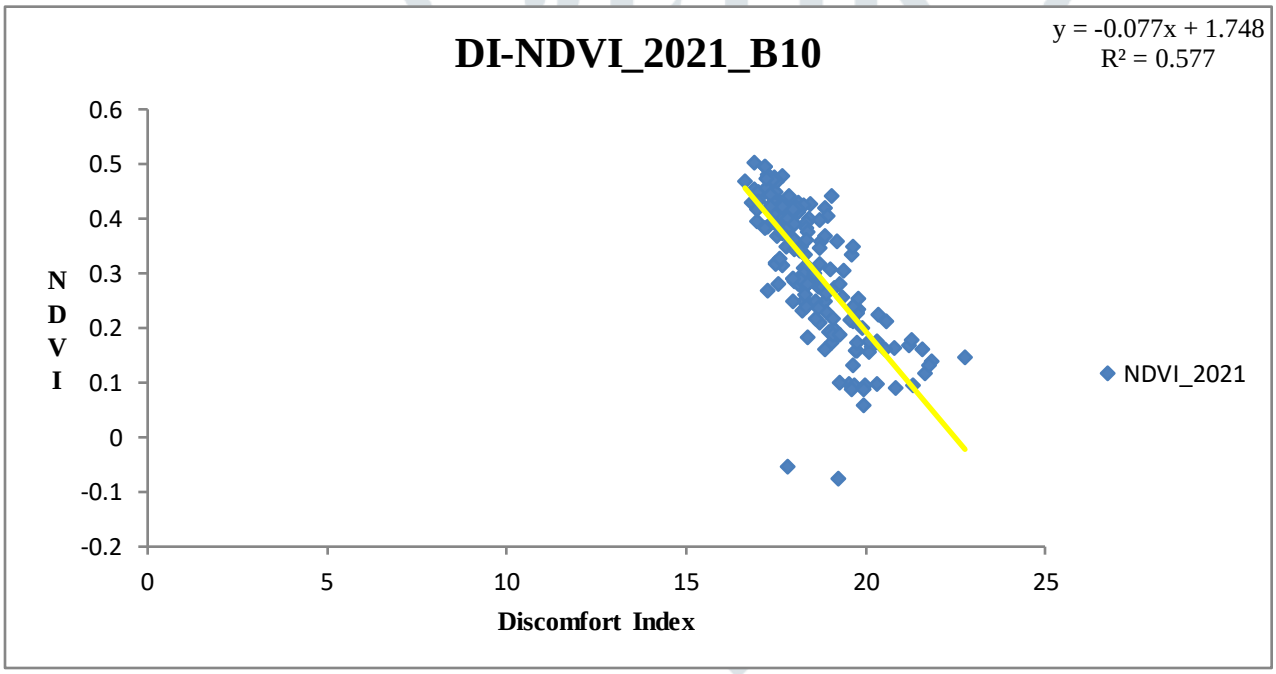
The relation between Discomfort Index and Normalized Difference Vegetation Index is given below:

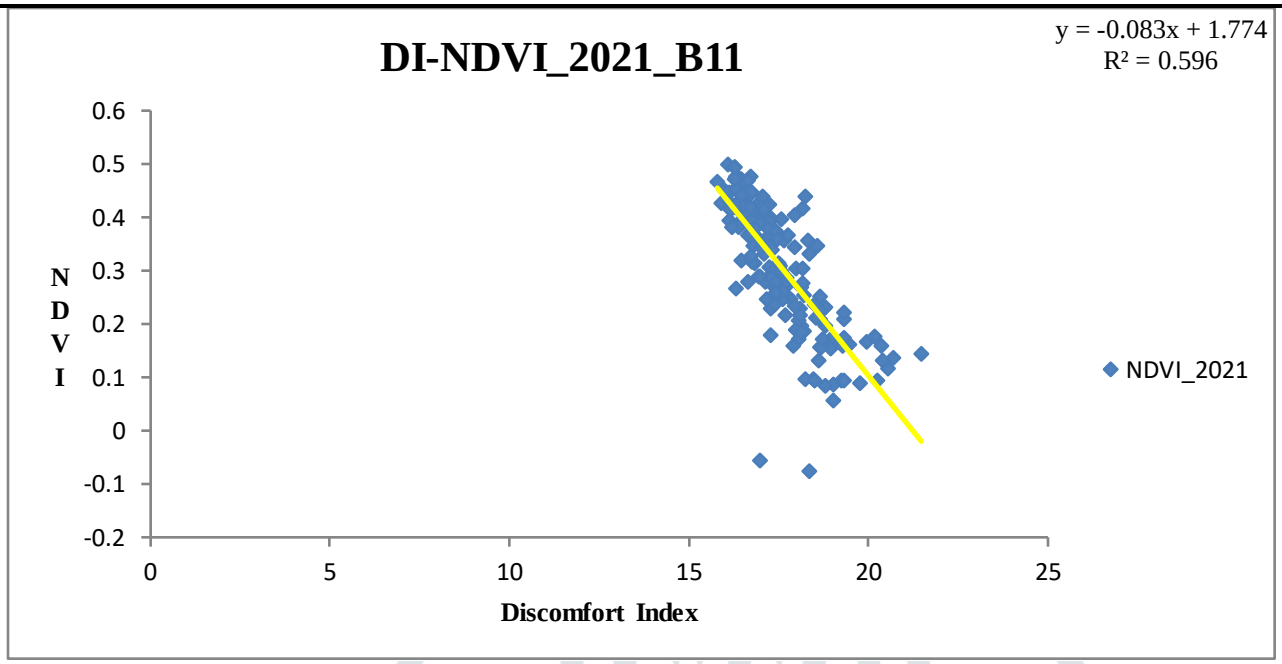



DI-NDVI_2001_vcid1
y = -0.1076x + 2.0931
R² = 0.6582
NDVI
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
0
5
10
15
20
25
Discomfort Index
NDVI_2001

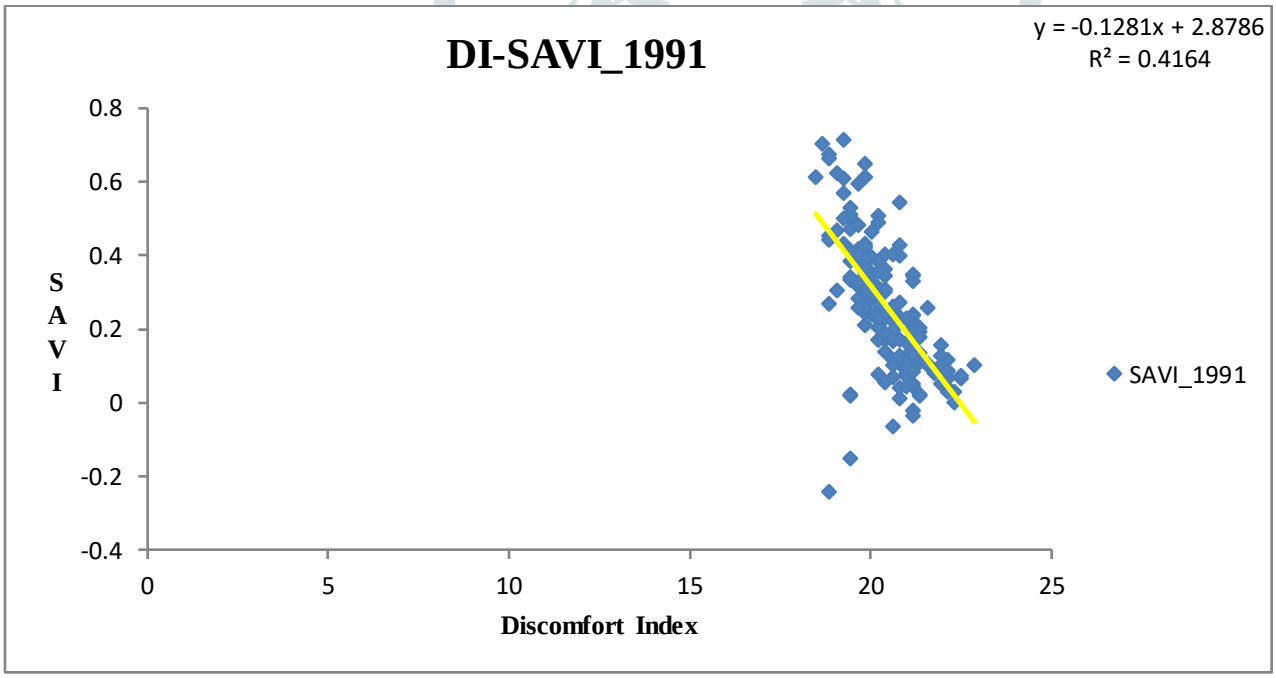

DI-NDVI_2001_vcid2
y = -0.1072x + 2.0863
R² = 0.656
NDVI
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
0
5
10
15
20
25
Discomfort Index
NDVI_2001

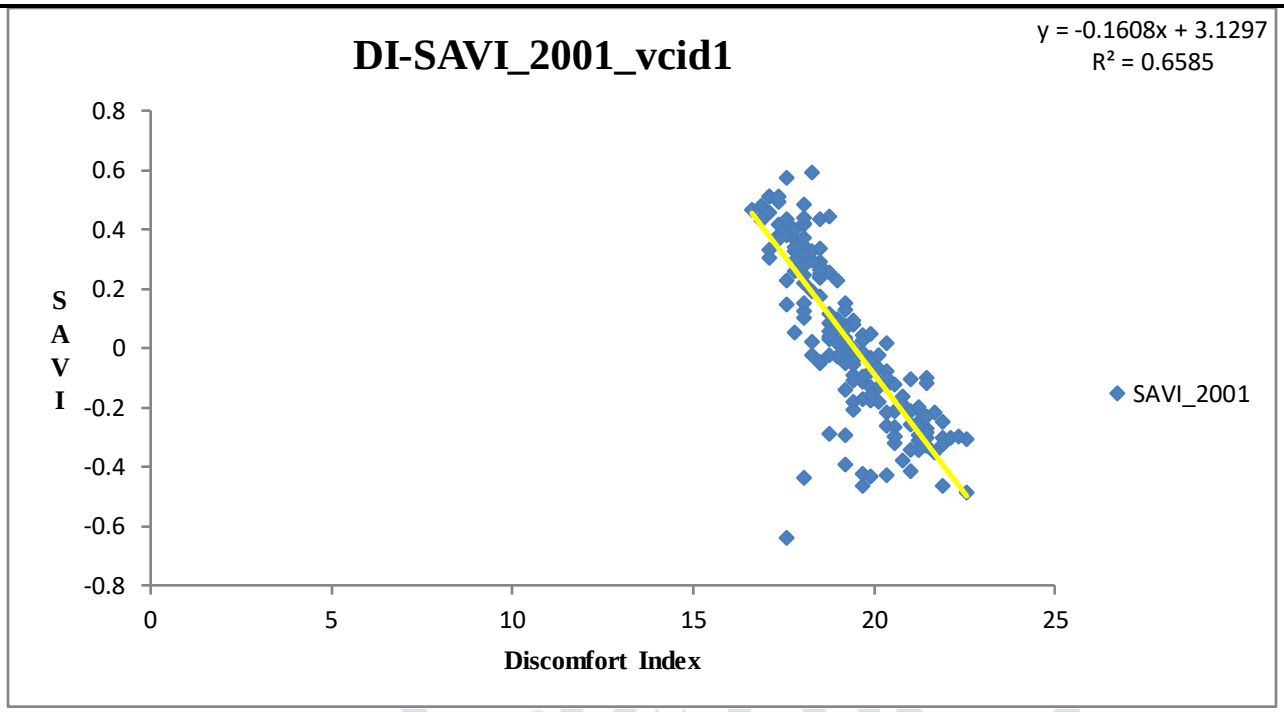

DI-NDVI_2011
y = -0.1262x + 2.8213
R² = 0.481
NDVI
Discomfort Index
NDVI_2011
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
0
5
10
15
20
25

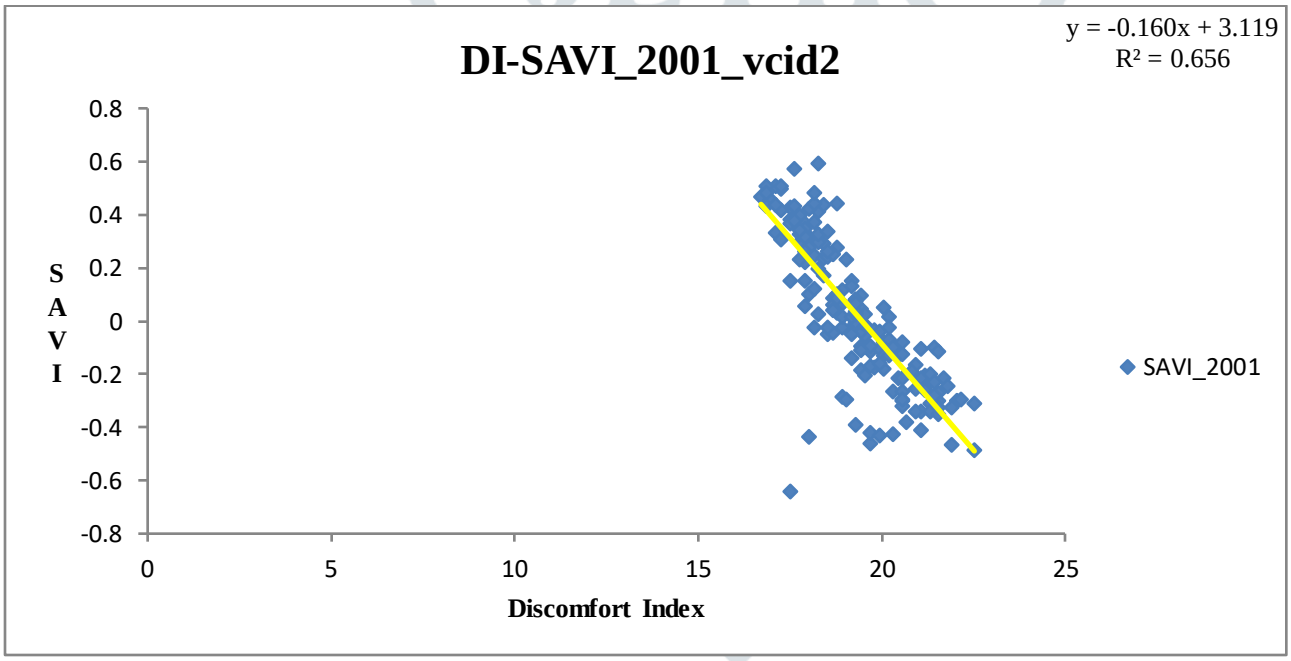

DI-NDVI_2021_B10
y = -0.077x + 1.748
R² = 0.577
NDVI
Discomfort Index
NDVI_2021
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
0
5
10
15
20
25

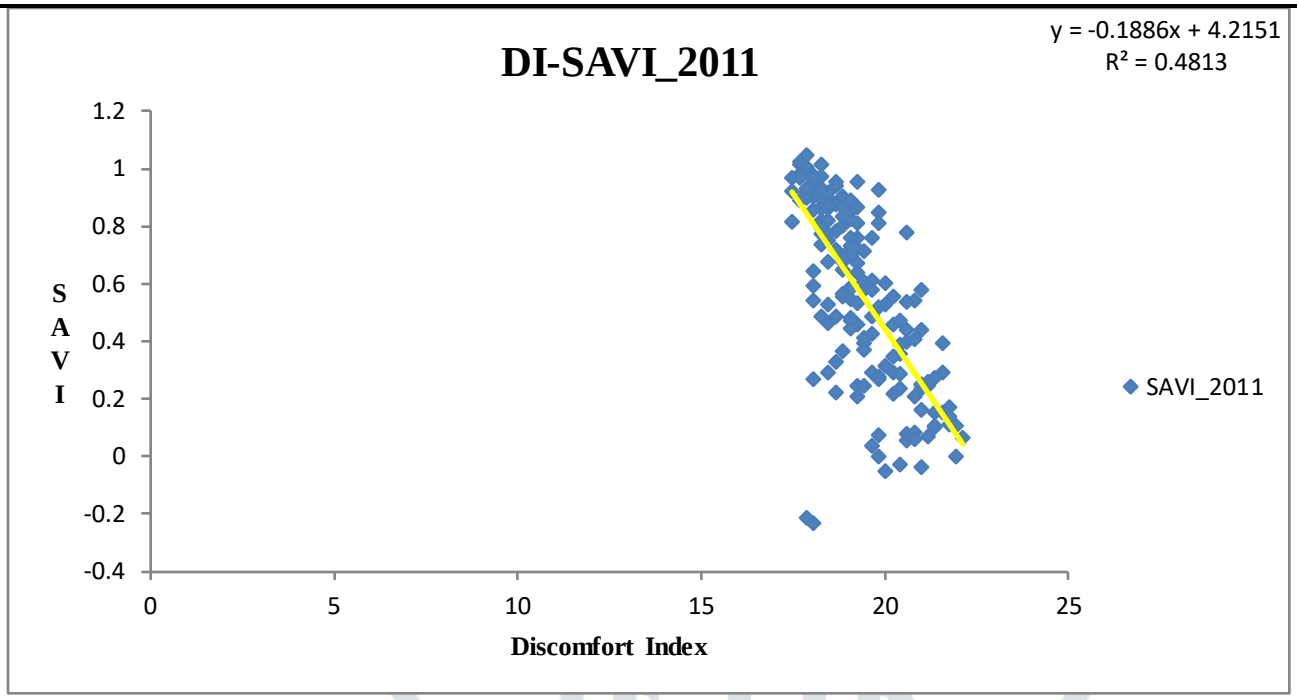


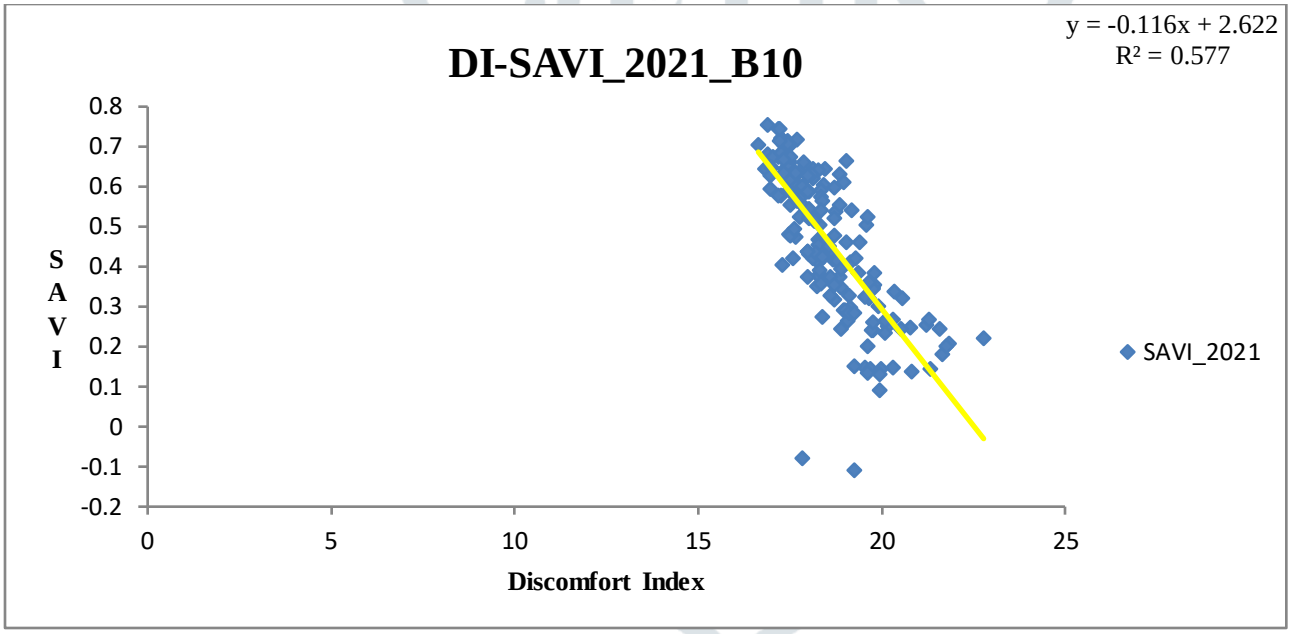
The relation between Discomfort Index and Soil Adjusted Vegetation Index is given below:

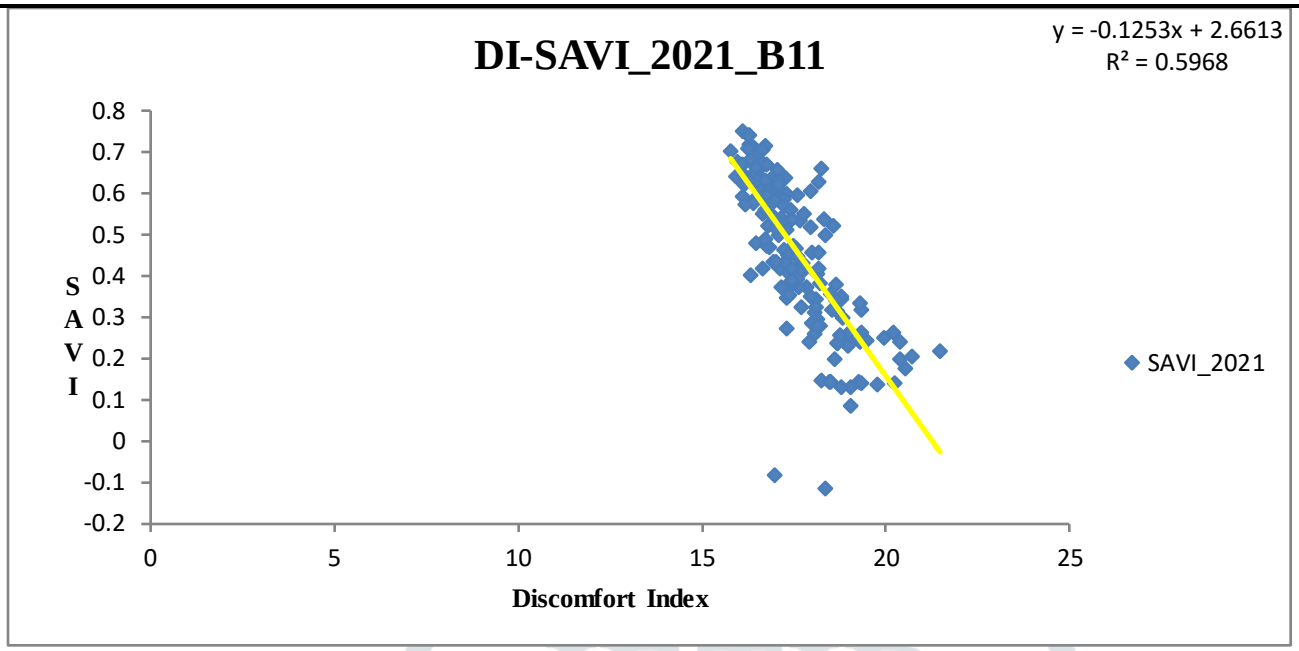



DI-SAVI_2001_vcid1
y = -0.1608x + 3.1297
R² = 0.6585
SAVI
Discomfort Index
SAVI_2001
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
5
10
15
20
25

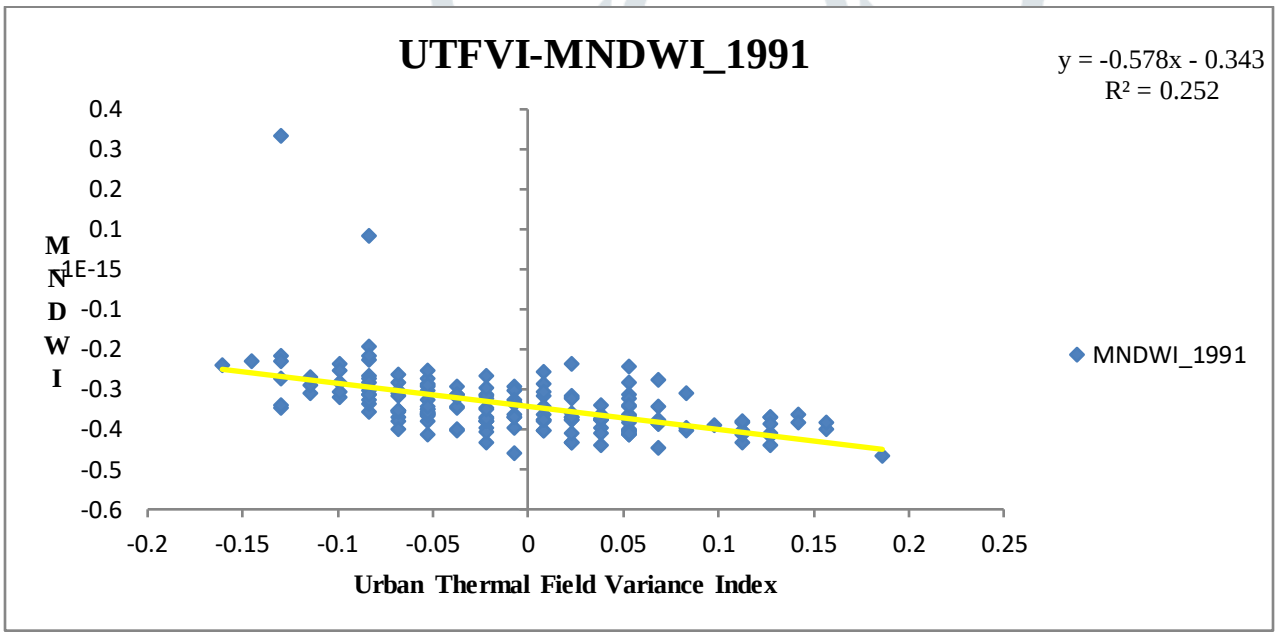

DI-SAVI_2001_vcid2
y = -0.160x + 3.119
R² = 0.656
SAVI
Discomfort Index
SAVI_2001
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
5
10
15
20
25

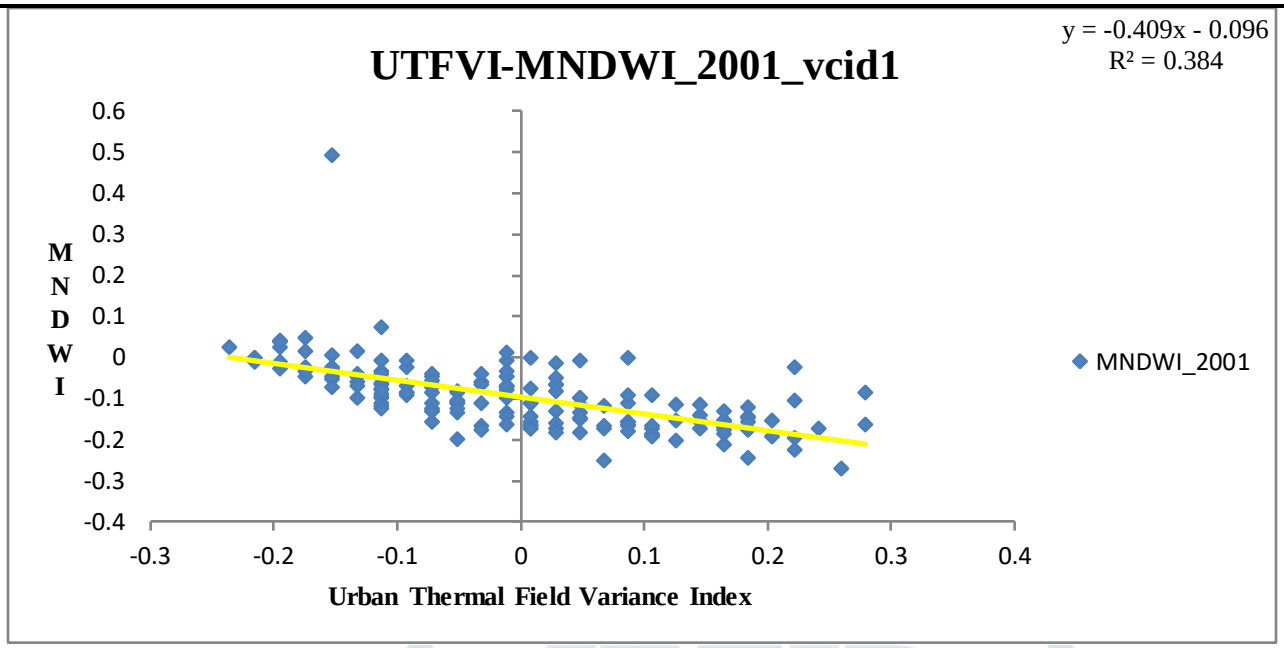

DI-SAVI_2011
y = -0.1886x + 4.2151
R² = 0.4813
SAVI
Discomfort Index
SAVI_2011

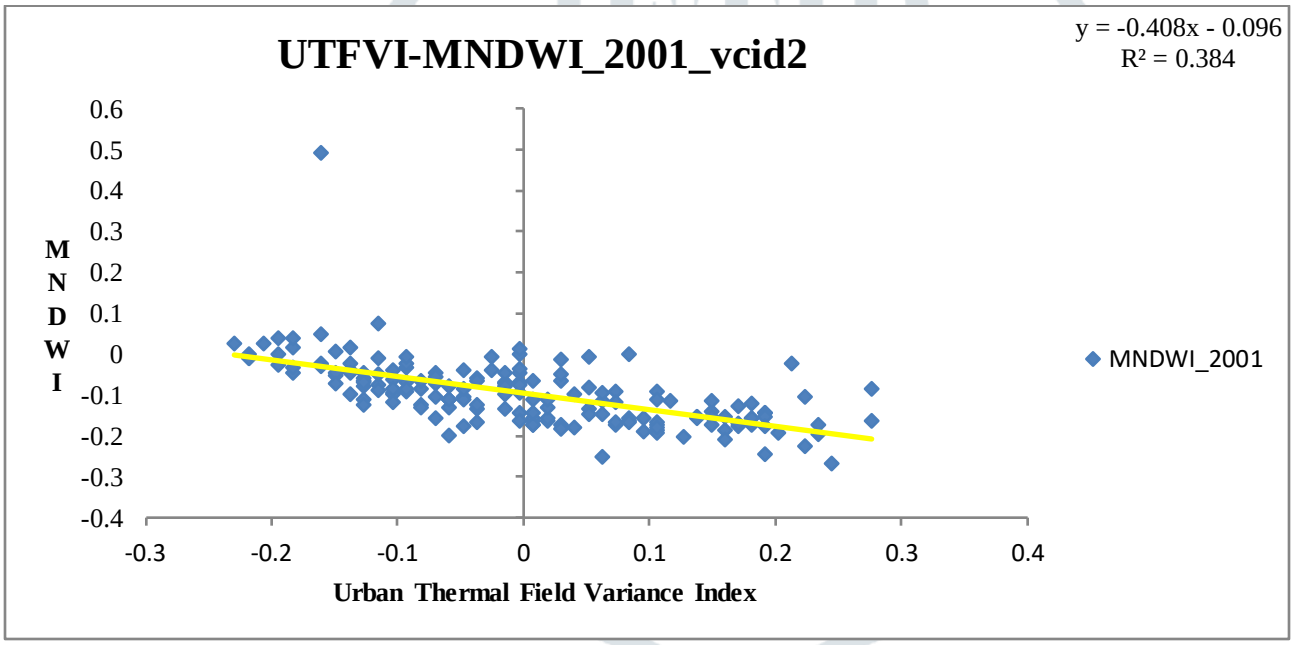

DI-SAVI_2021_B10
y = -0.116x + 2.622
R² = 0.577
SAVI
Discomfort Index
SAVI_2021

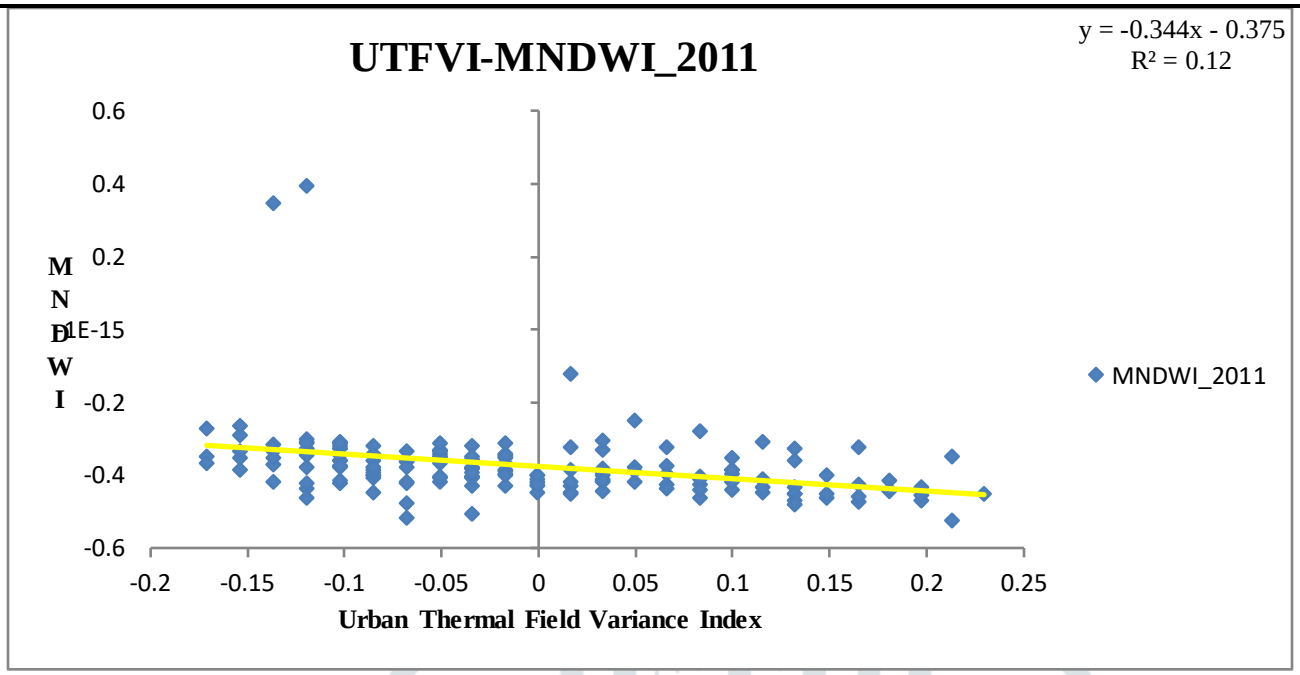


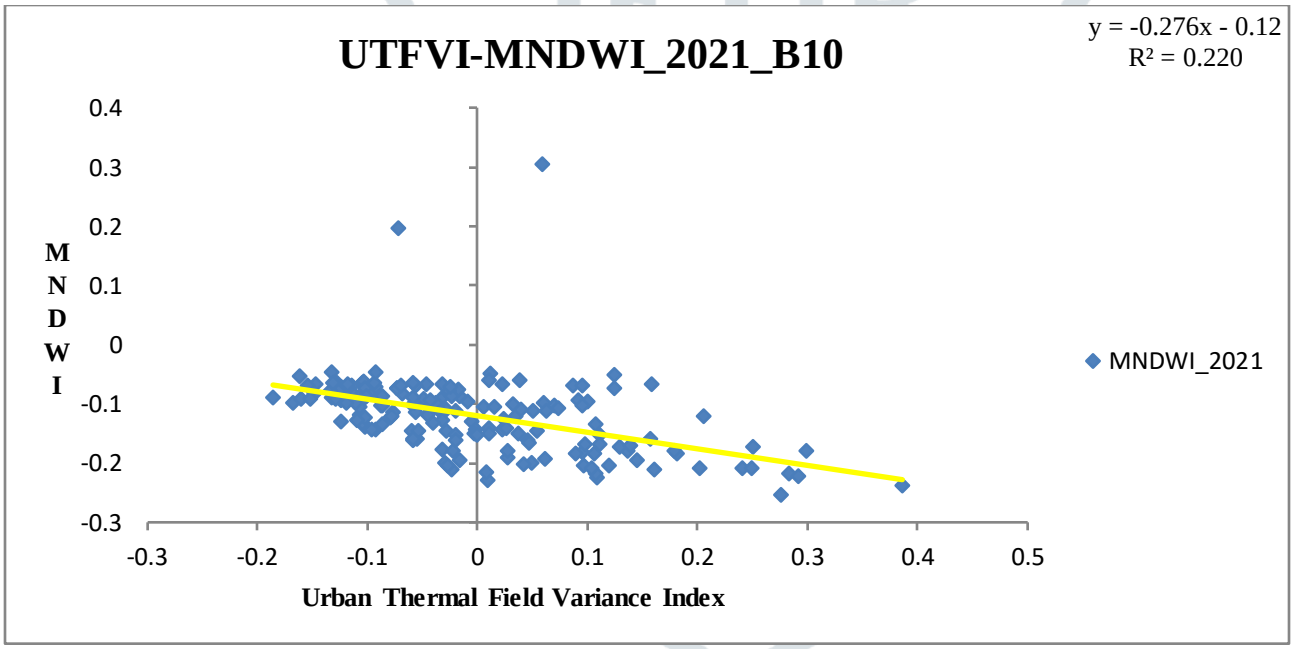
The relation between Urban Thermal Field Variance Index and Modified Normalized Difference Water Index is given below:

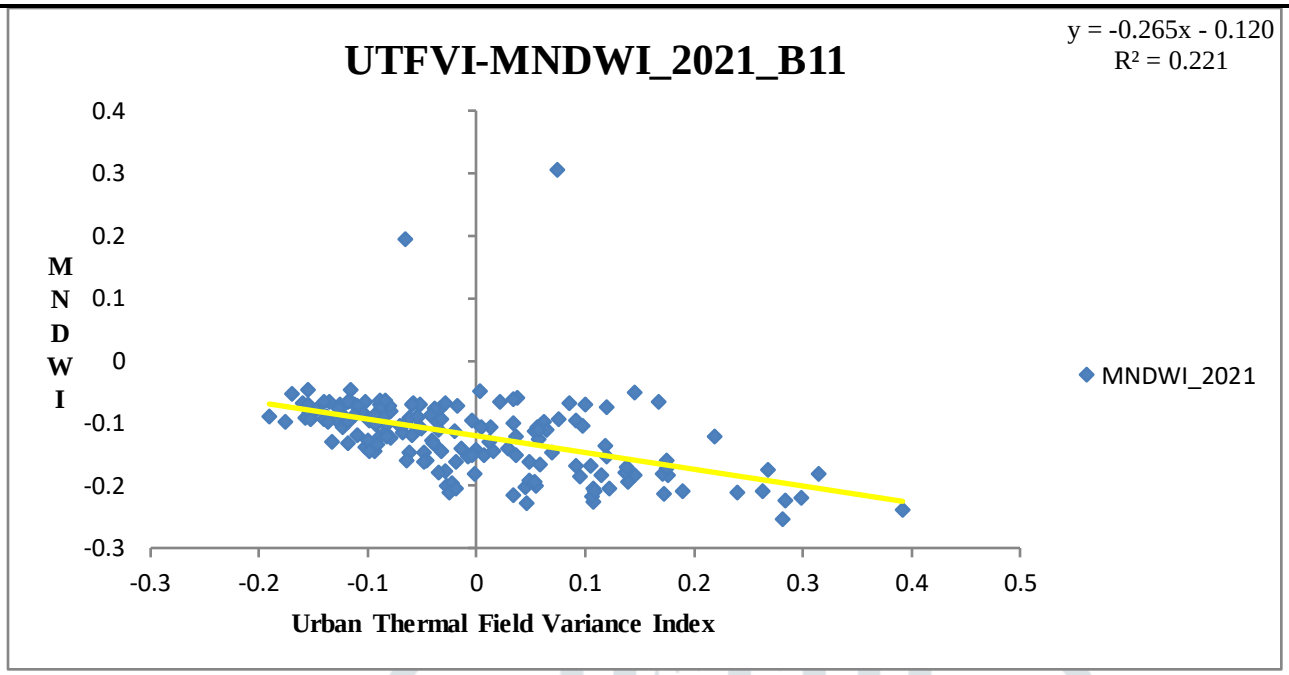



UTFVI-MNDWI_2001_vcid1
y = -0.409x - 0.096
R² = 0.384
MNDWI
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
Urban Thermal Field Variance Index
MNDWI_2001

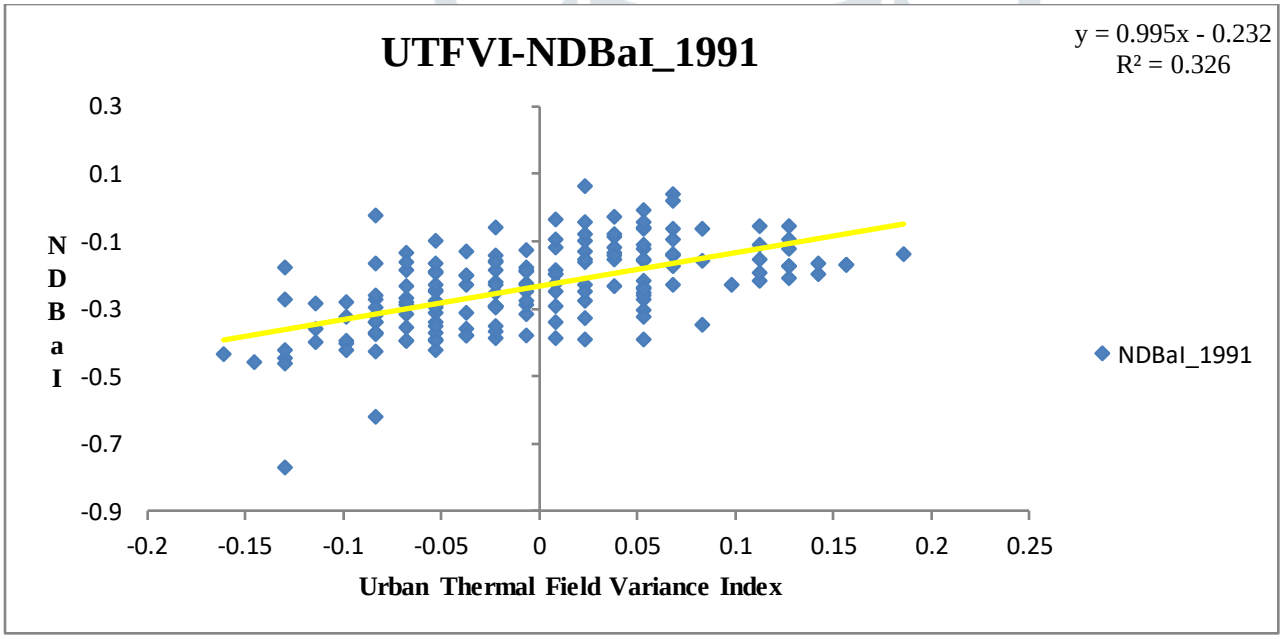

UTFVI-MNDWI_2001_vcid2
y = -0.408x - 0.096
R² = 0.384
MNDWI
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
Urban Thermal Field Variance Index
MNDWI_2001

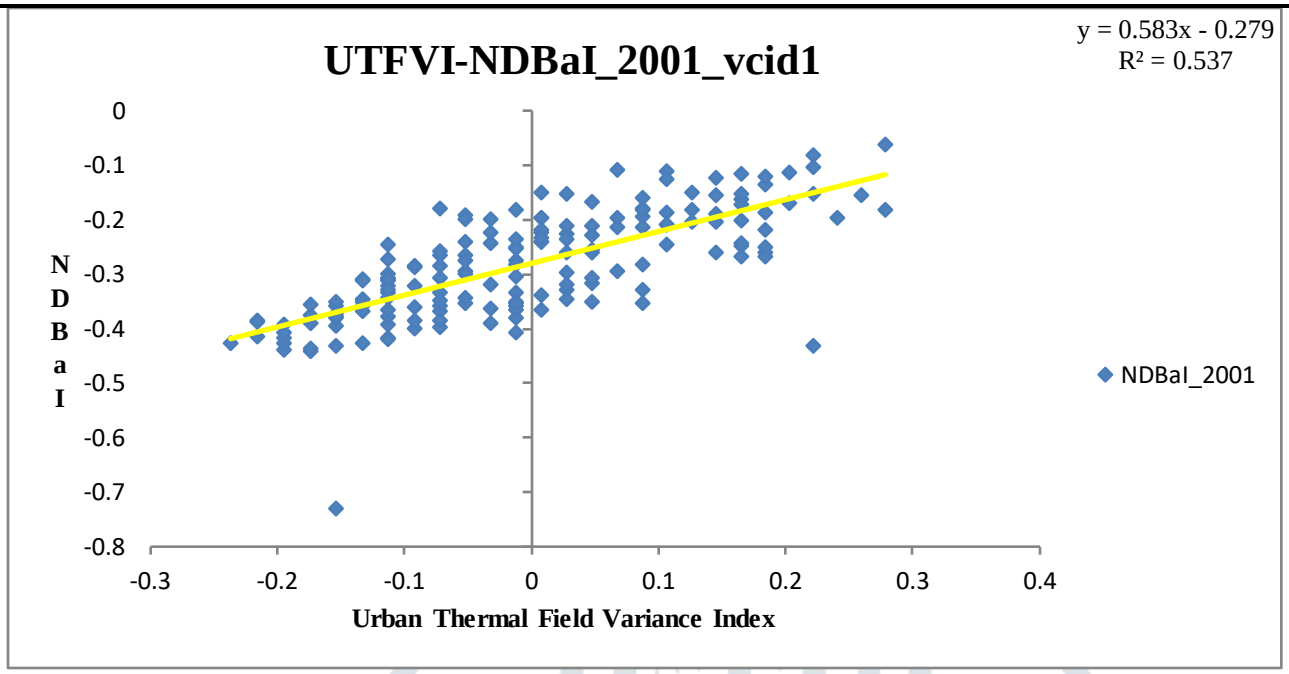

UTFVI-MNDWI_2011
y = -0.344x - 0.375
R² = 0.12
MNDWI
0.6
0.4
0.2
1E-15
-0.2
-0.4
-0.6
-0.2
-0.15
-0.1
-0.05
0
0.05
0.1
0.15
0.2
0.25
Urban Thermal Field Variance Index
MNDWI_2011

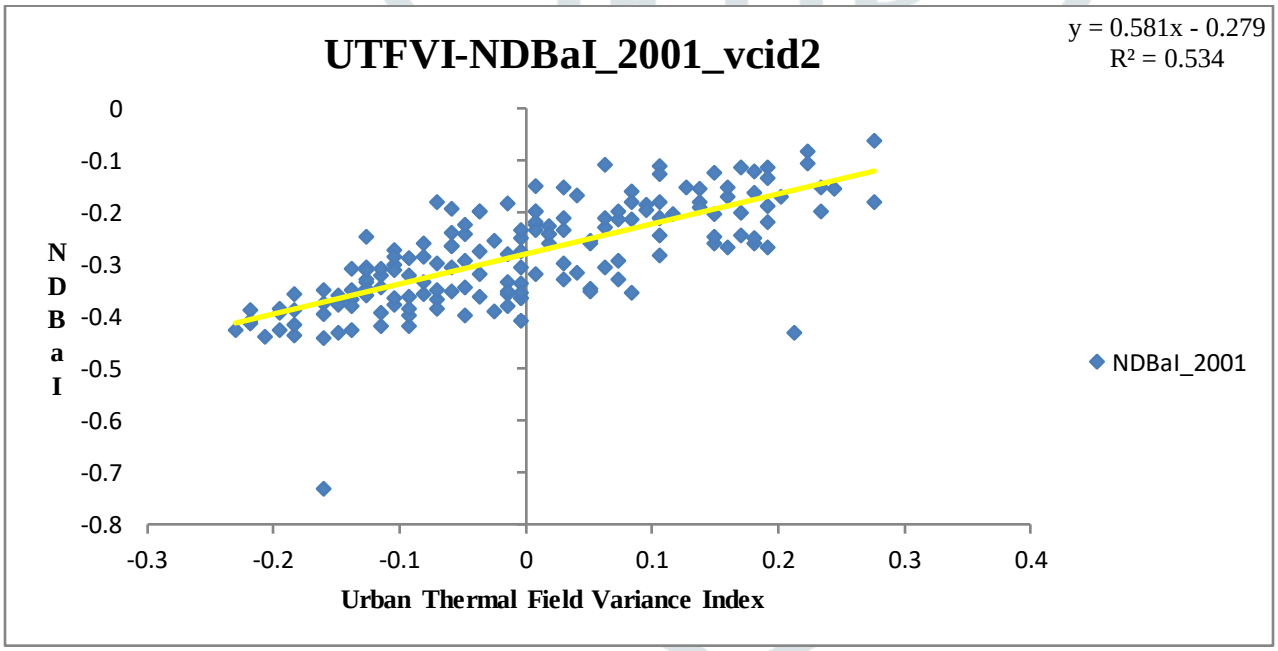

UTFVI-MNDWI_2021_B10
y = -0.276x - 0.12
R² = 0.220
MNDWI
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
Urban Thermal Field Variance Index
MNDWI_2021

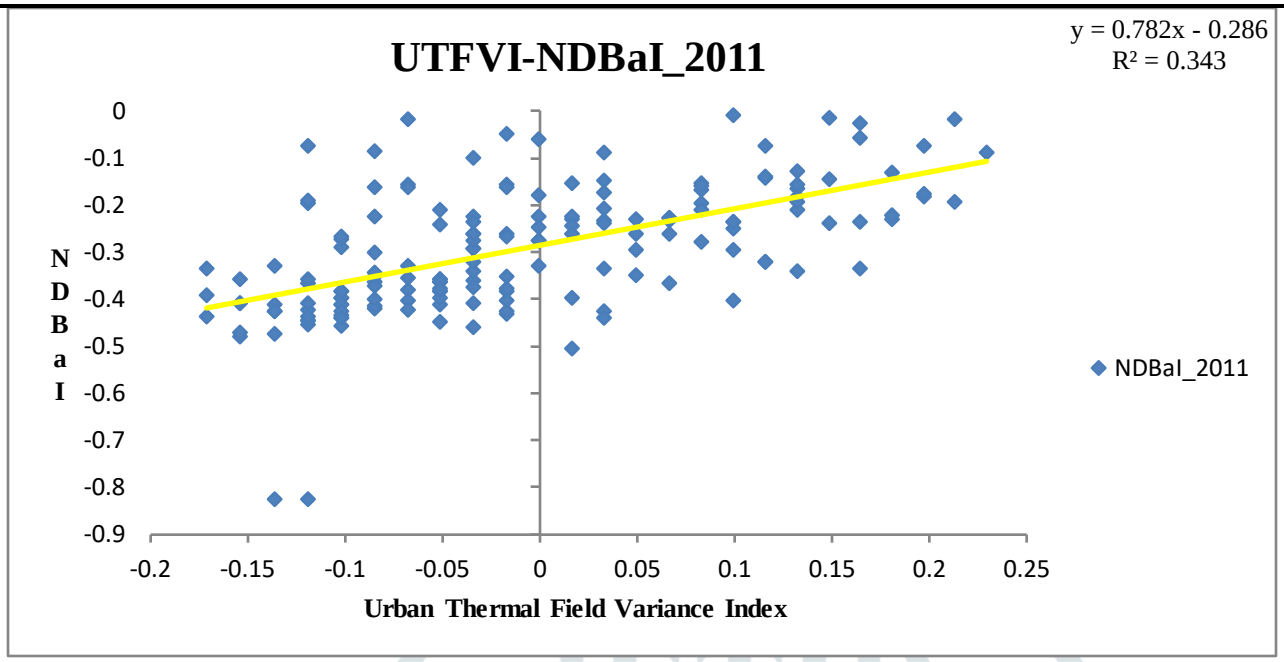


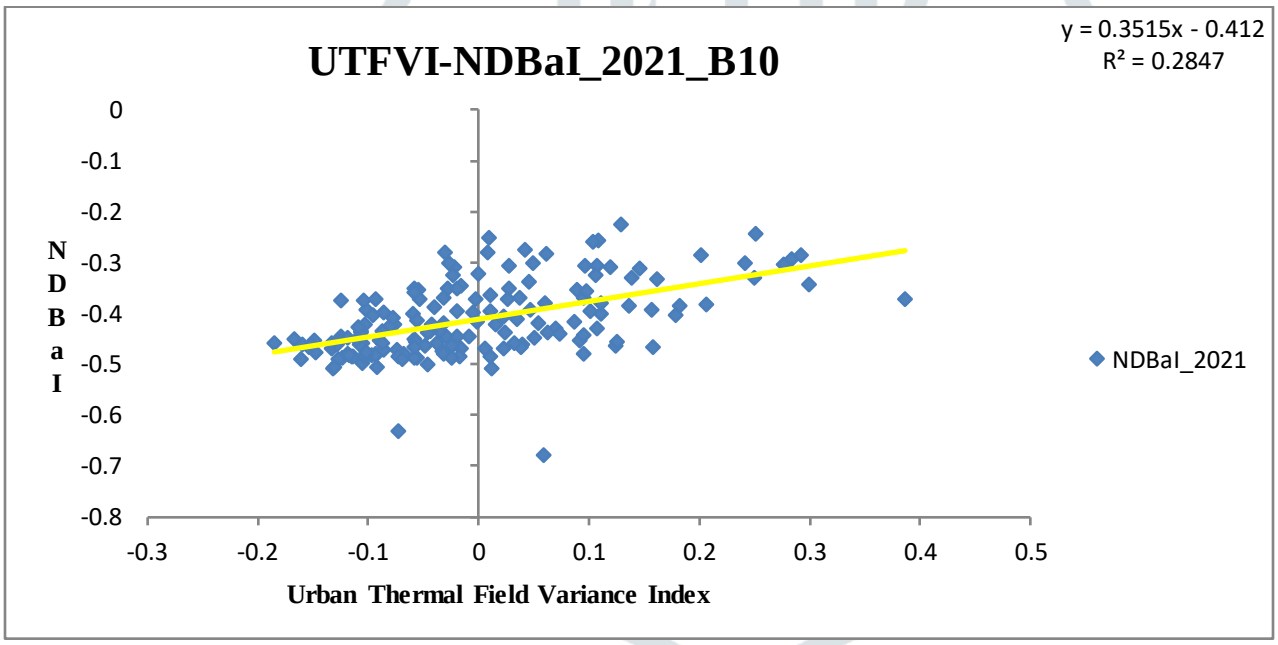
The relation between Urban Thermal Field Variance Index and Normalized Difference Barren Index is given below:

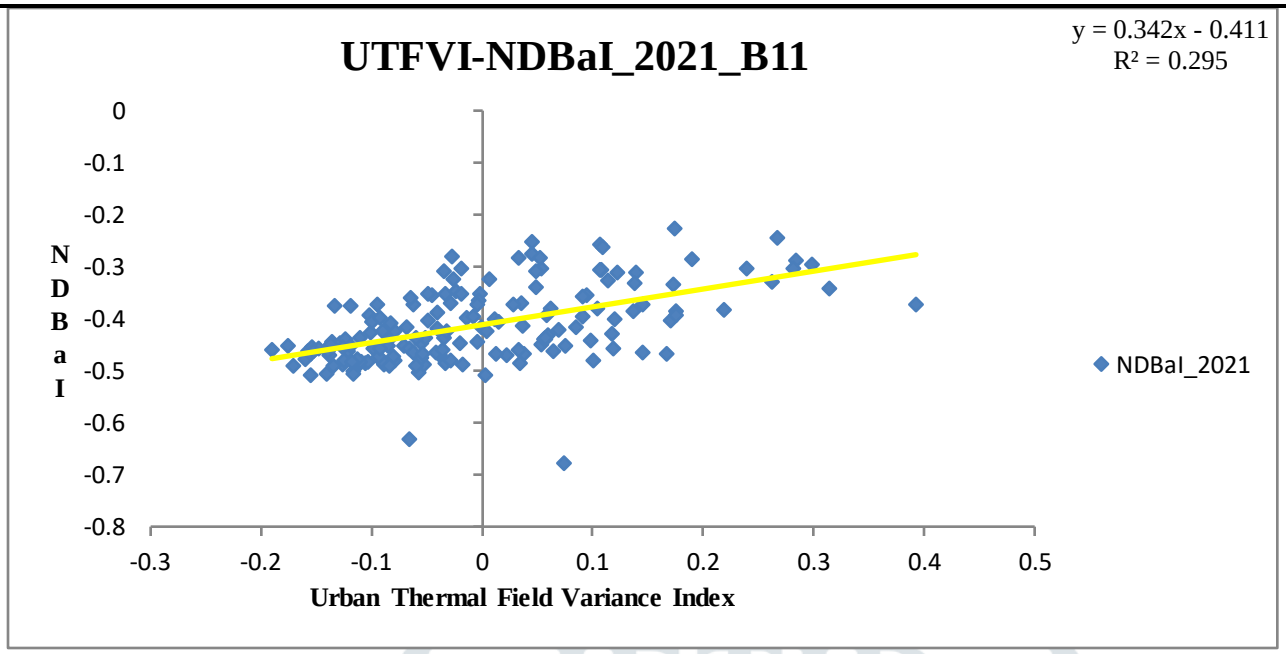



UTFVI-NDBaI_2001_vcid1
y = 0.583x - 0.279
R² = 0.537
NDBaI
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
Urban Thermal Field Variance Index
NDBaI_2001

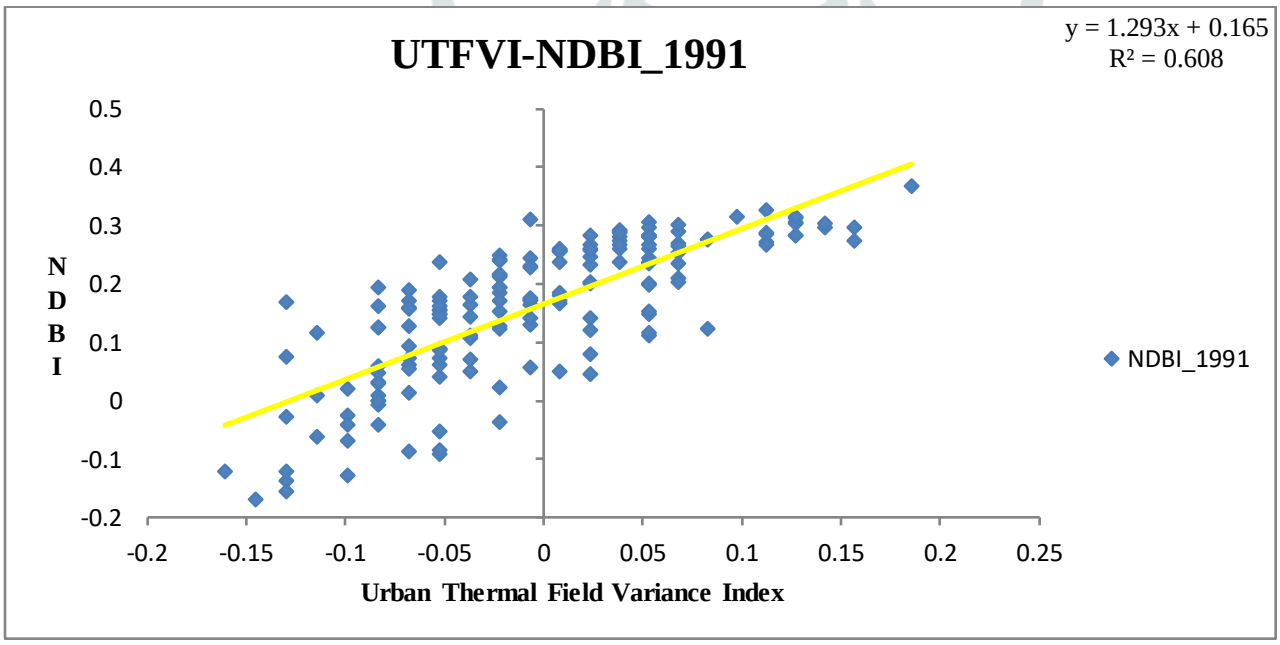

UTFVI-NDBaI_2001_vcid2
y = 0.581x - 0.279
R² = 0.534
NDBaI
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
Urban Thermal Field Variance Index
NDBaI_2001

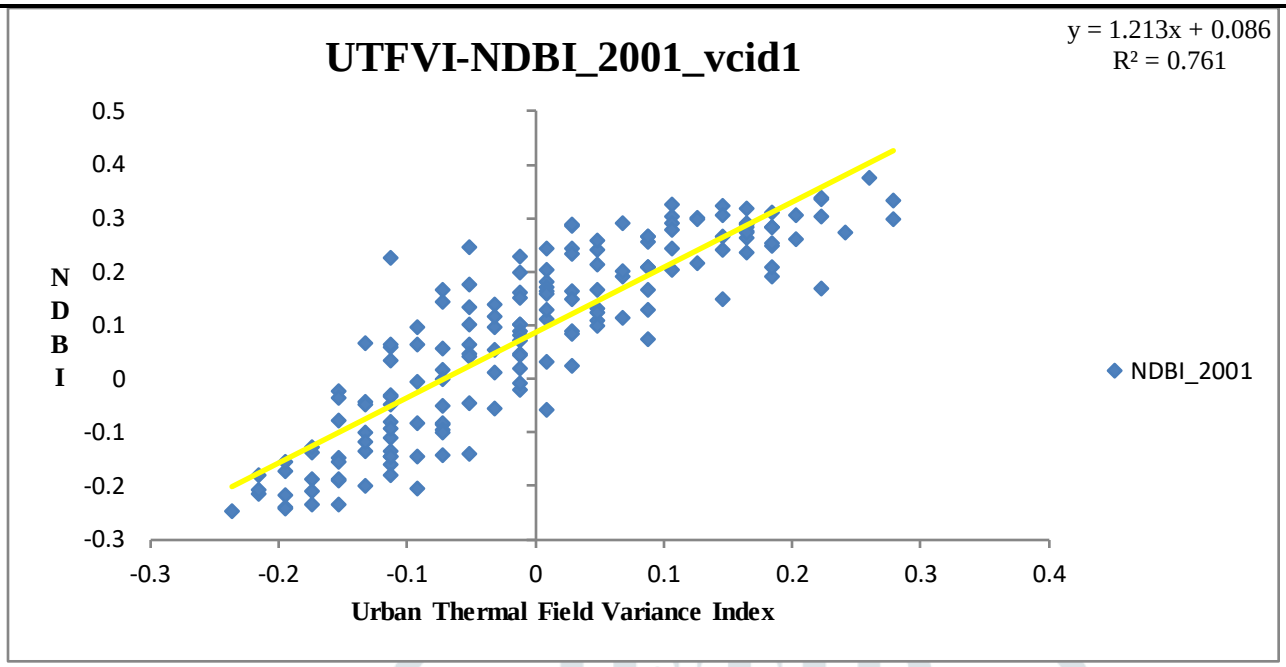

UTFVI-NDBaI_2011
y = 0.782x - 0.286
R² = 0.343
NDBaI
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-0.2
-0.15
-0.1
-0.05
0
0.05
0.1
0.15
0.2
0.25
Urban Thermal Field Variance Index
NDBaI_2011

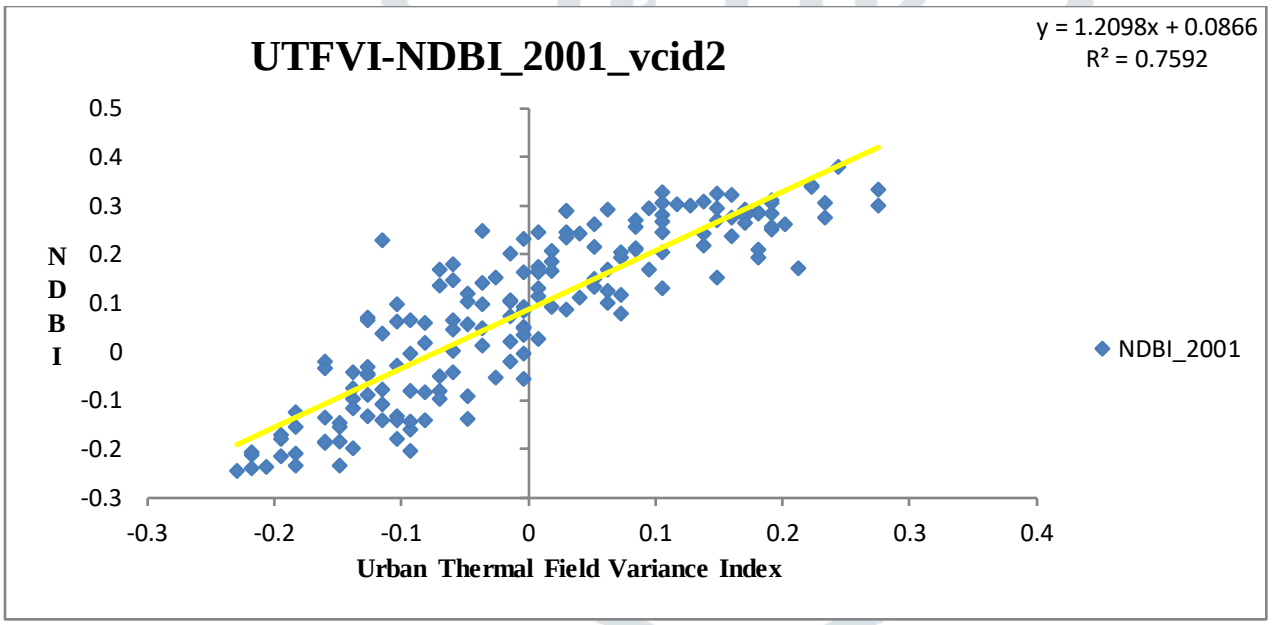

UTFVI-NDBaI_2021_B10
y = 0.3515x - 0.412
R² = 0.2847
NDBaI
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
Urban Thermal Field Variance Index
NDBaI_2021

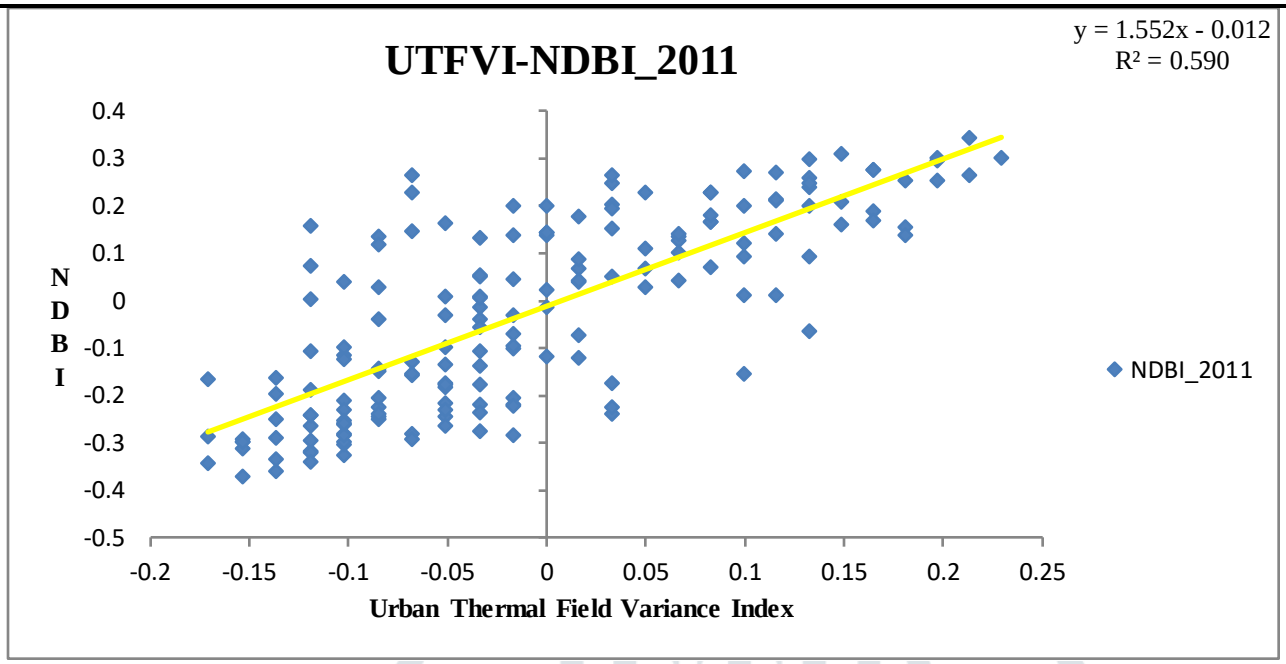


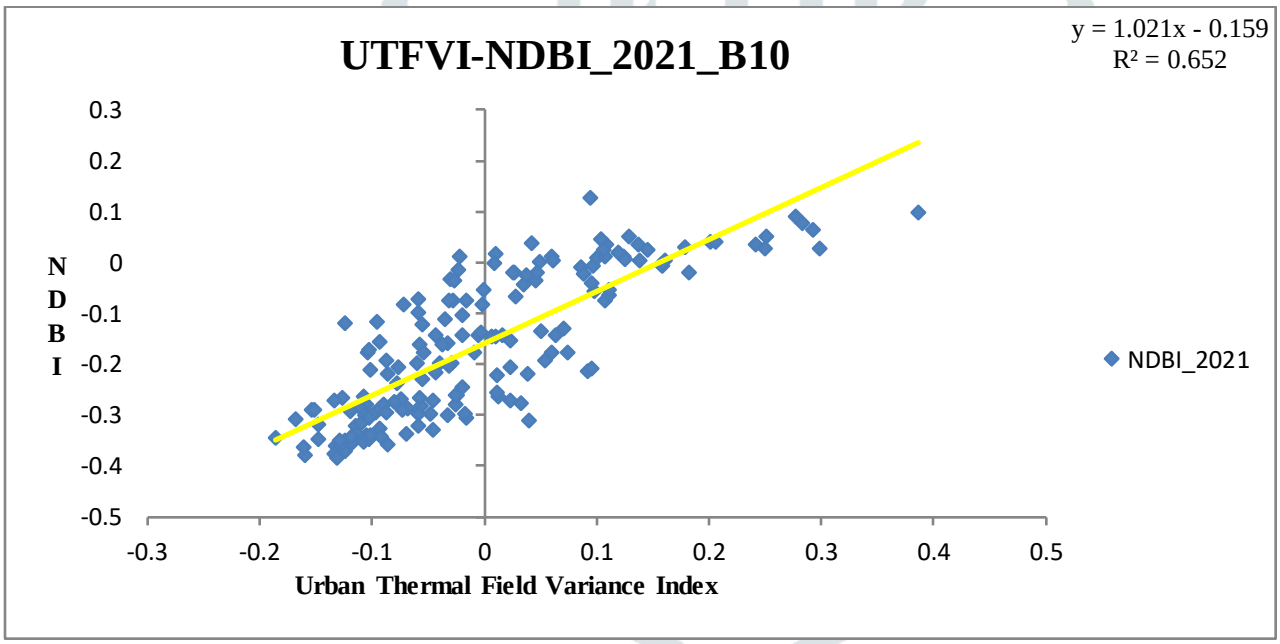
The relation between Urban Thermal Field Variance Index and Normalized Difference Built-up Index is given below:

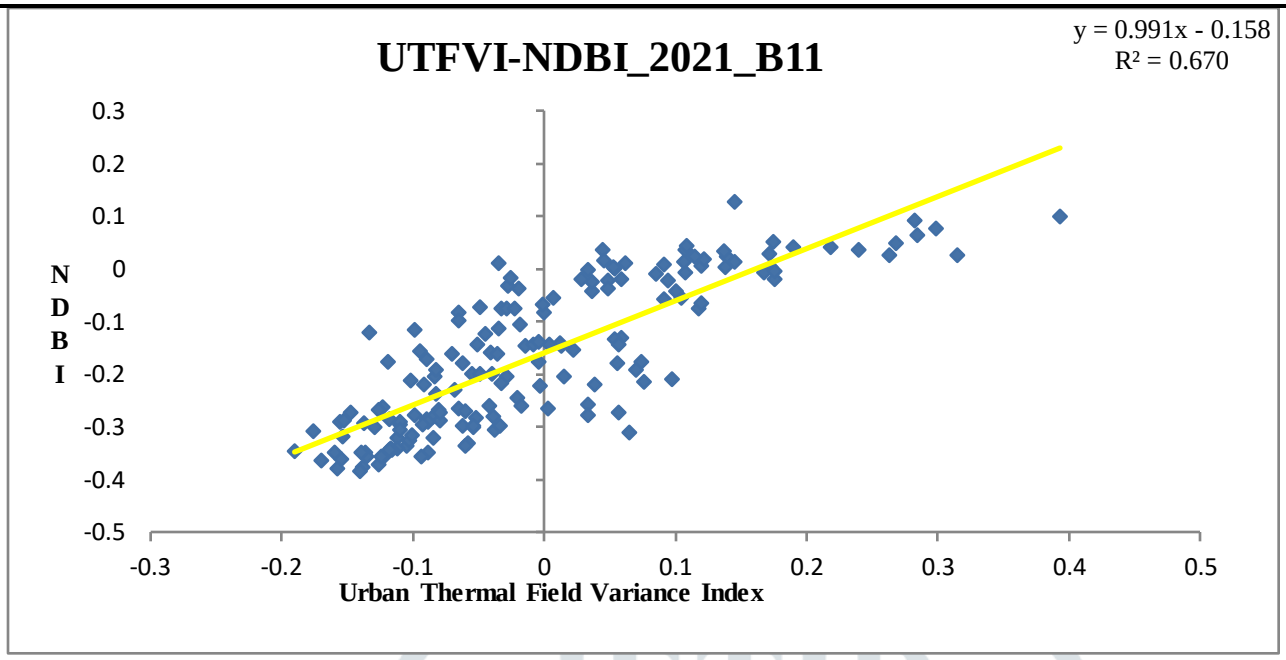



UTFVI-NDBI_2001_vcid1
y = 1.213x + 0.086
R² = 0.761
NDBI
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
Urban Thermal Field Variance Index
NDBI_2001

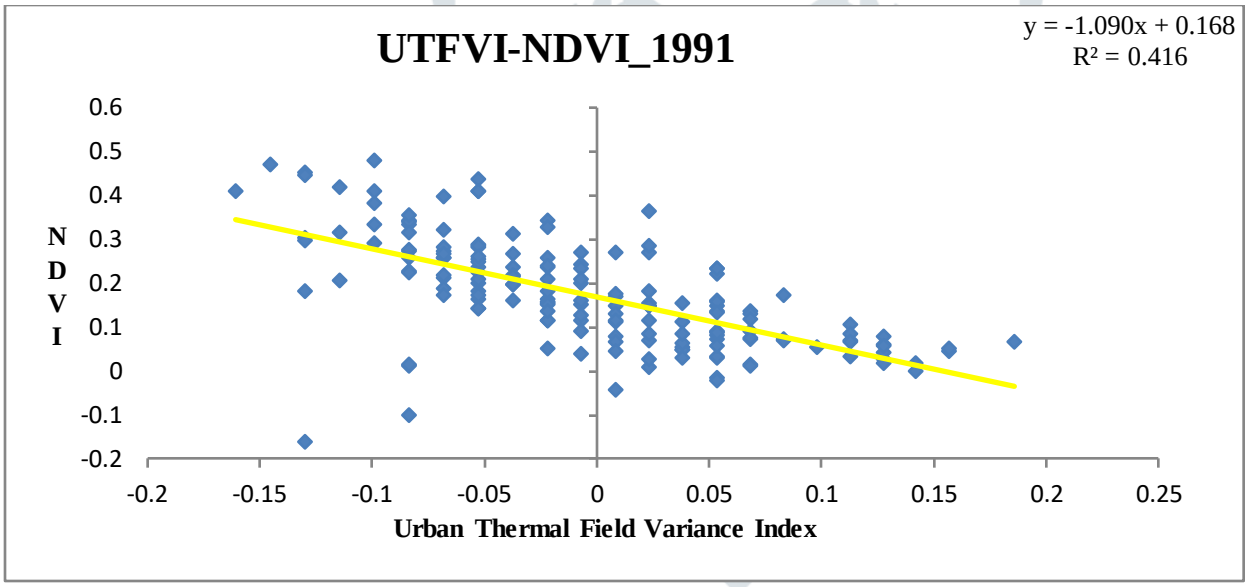

UTFVI-NDBI_2001_vcid2
y = 1.2098x + 0.0866
R² = 0.7592
NDBI
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
Urban Thermal Field Variance Index
NDBI_2001

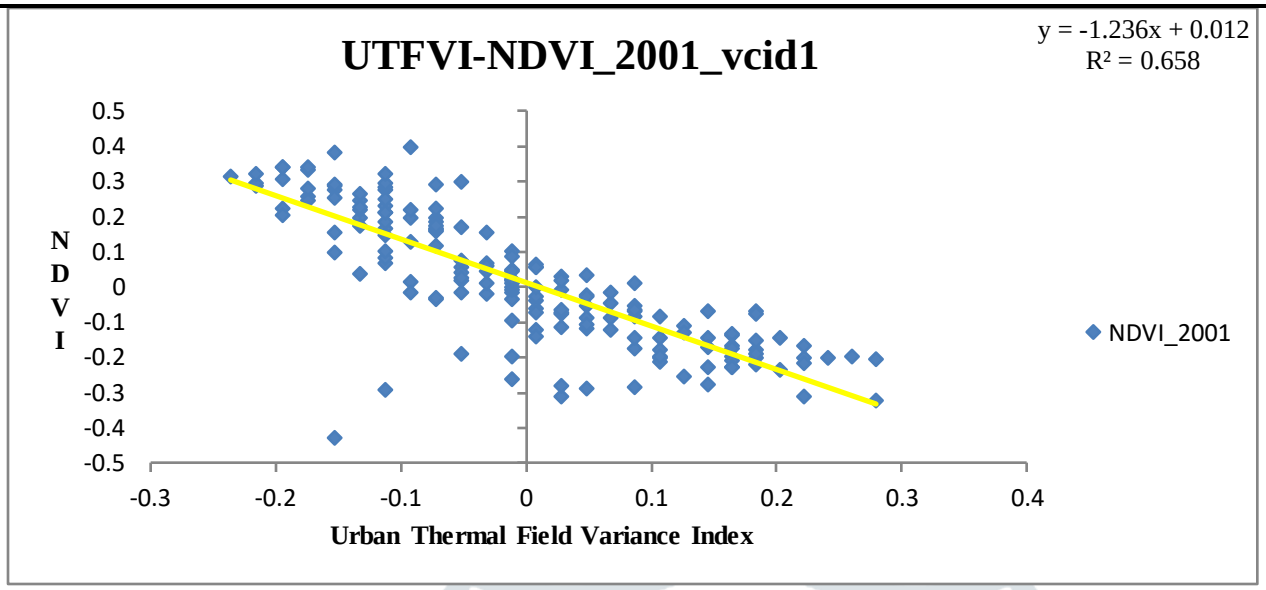

UTFVI-NDBI_2011
y = 1.552x - 0.012
R² = 0.590
NDBI
Urban Thermal Field Variance Index
NDBI_2011

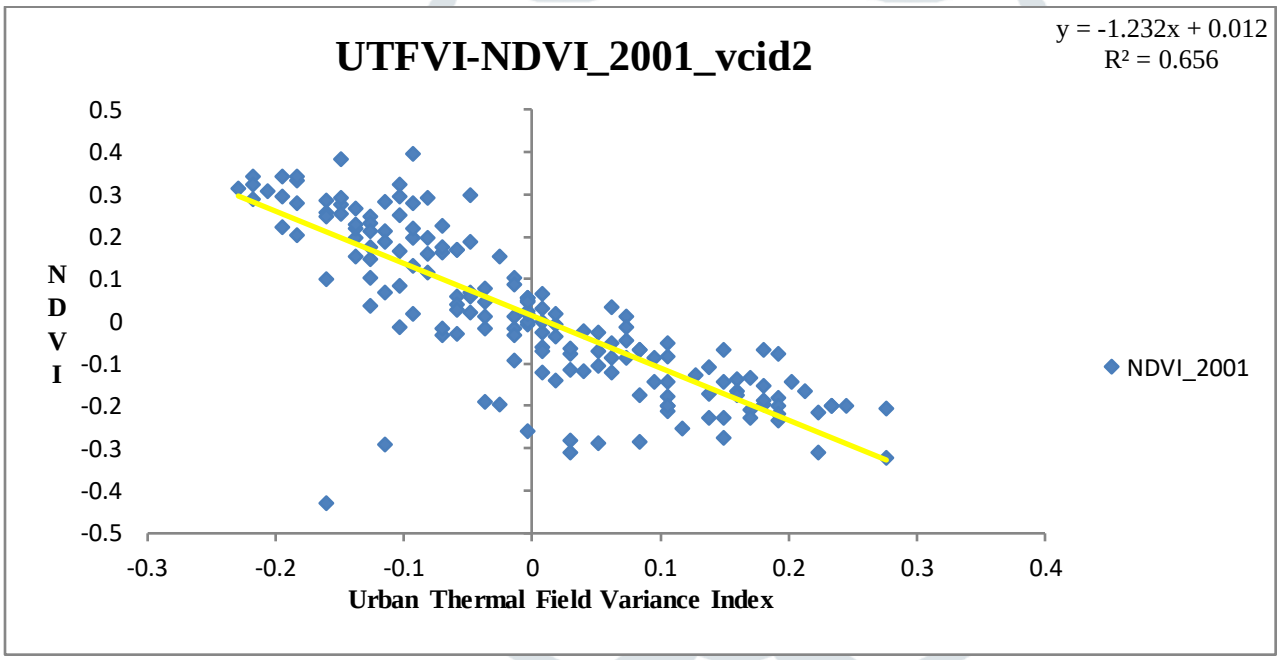

UTFVI-NDBI_2021_B10
y = 1.021x - 0.159
R² = 0.652
NDBI
Urban Thermal Field Variance Index
NDBI_2021

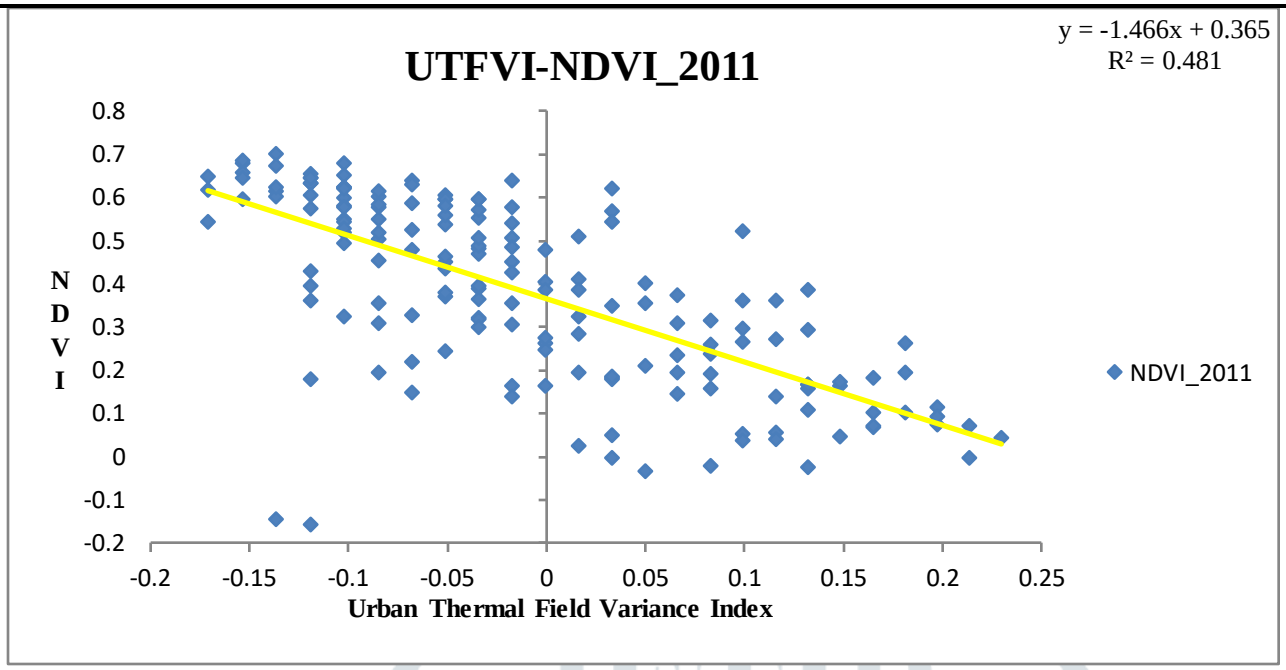


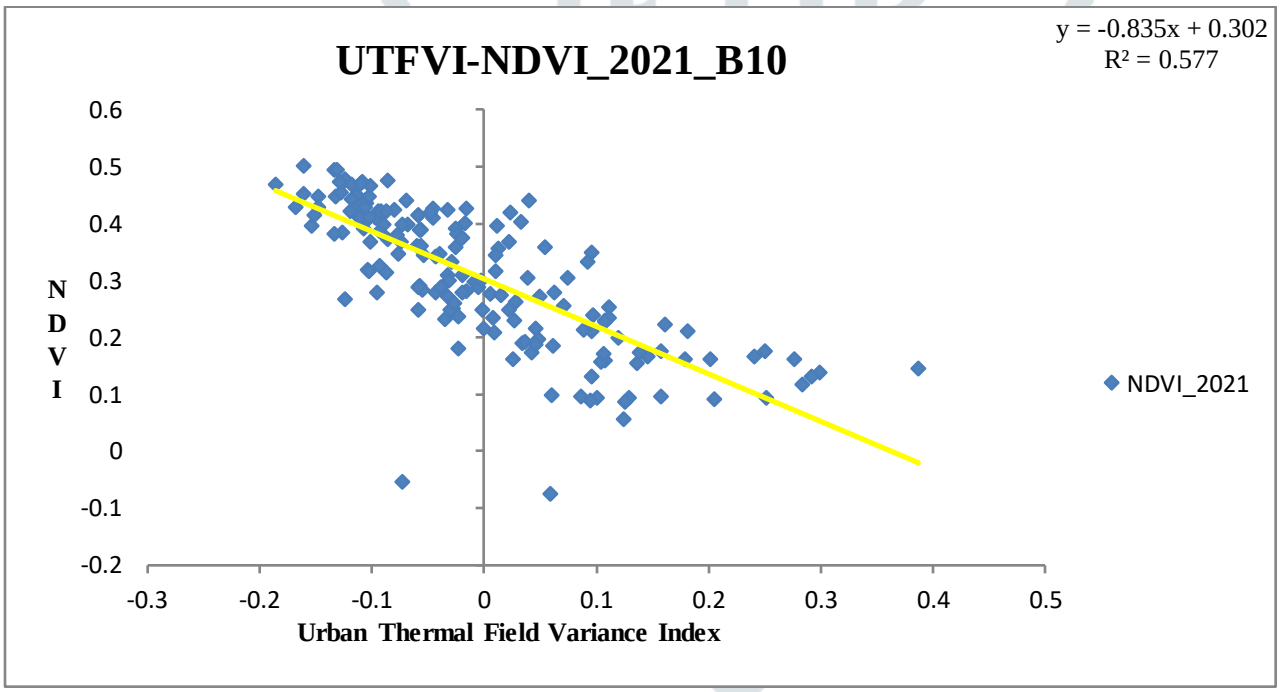
The relation between Urban Thermal Field Variance Index and Normalized Difference Vegetation Index is given below:

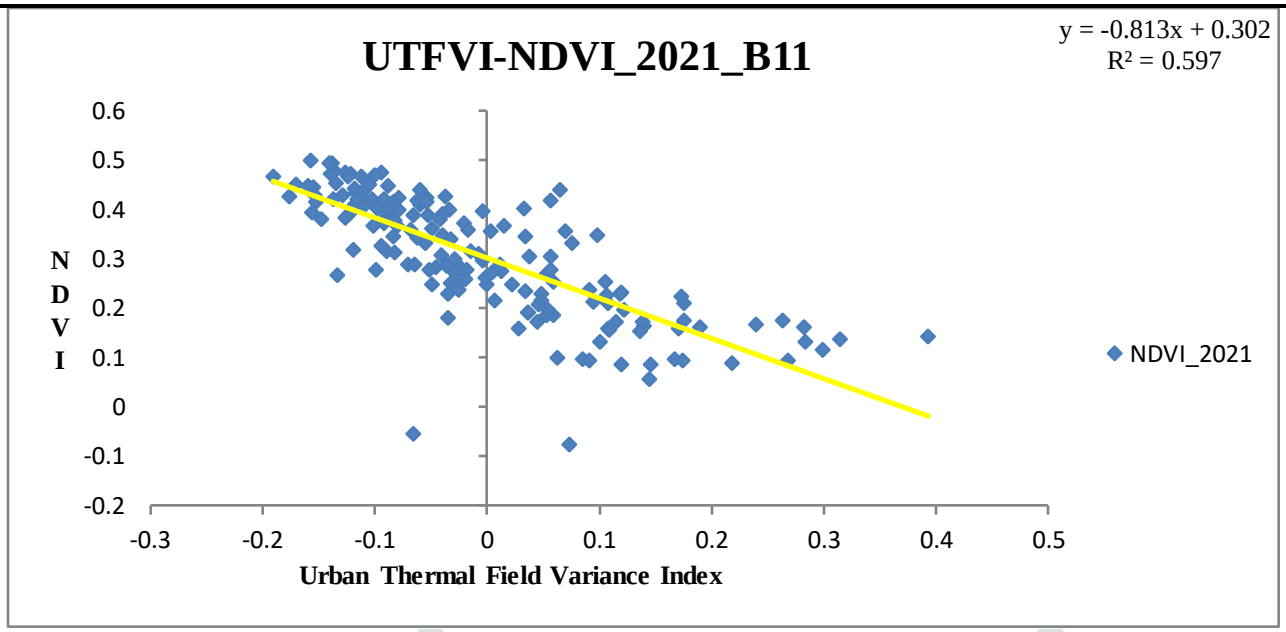



UTFVI-NDVI_2001_vcid1
y = -1.236x + 0.012
R² = 0.658
NDVI
Urban Thermal Field Variance Index
NDVI_2001

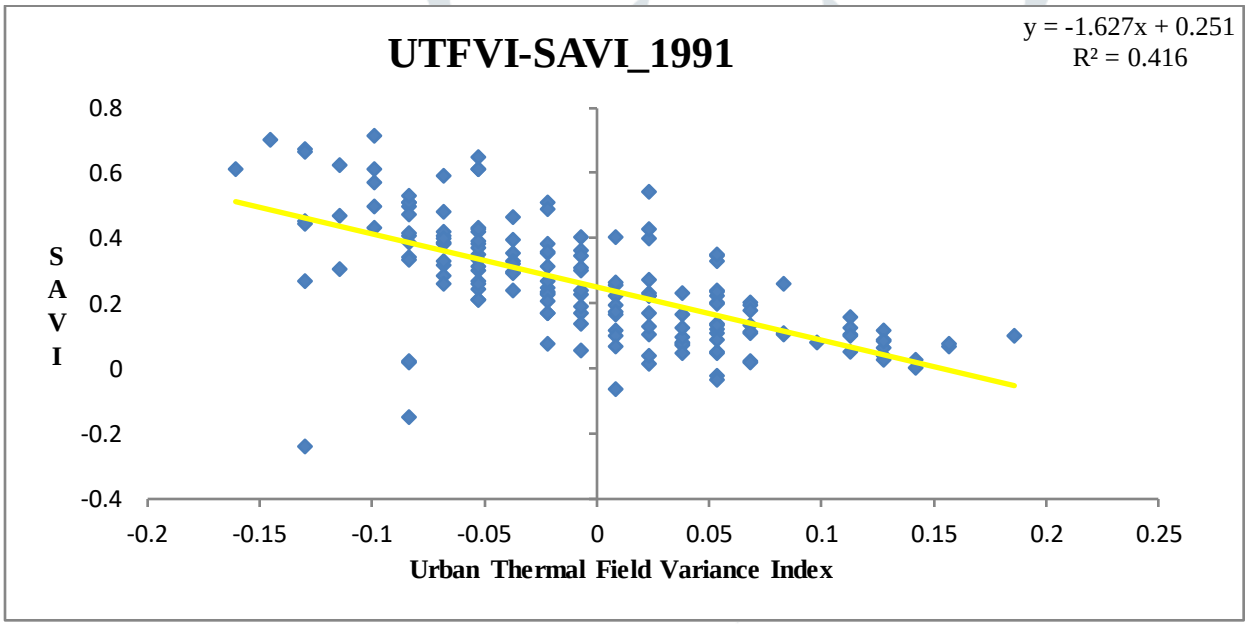

UTFVI-NDVI_2001_vcid2
y = -1.232x + 0.012
R² = 0.656
NDVI
Urban Thermal Field Variance Index
NDVI_2001

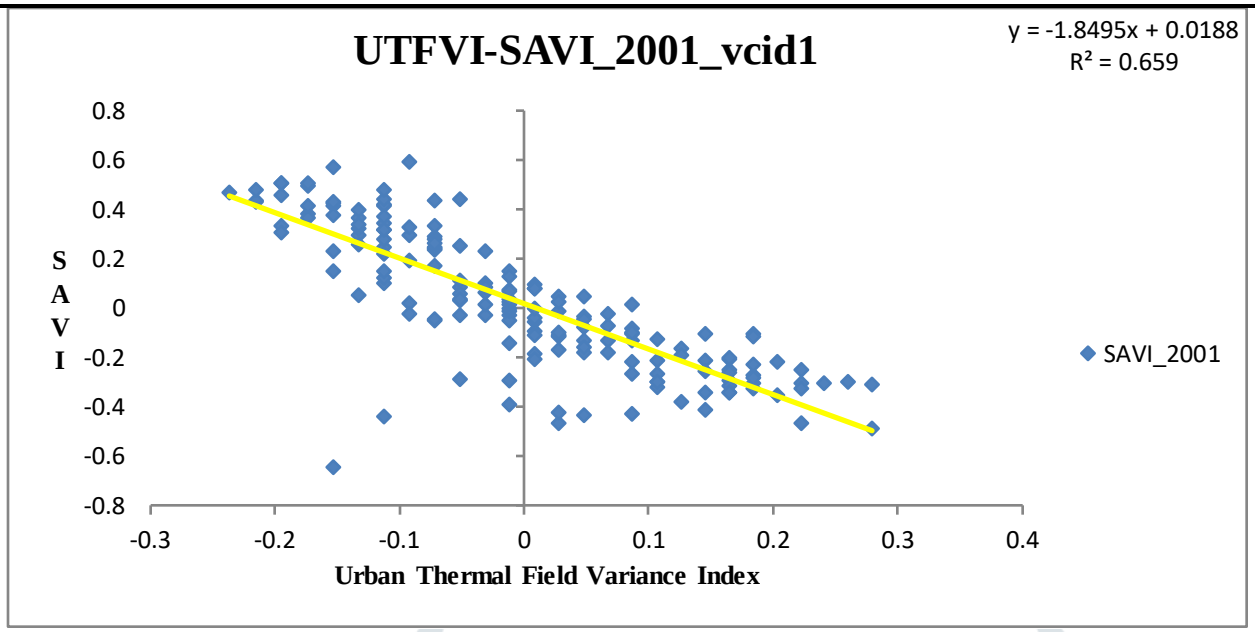

UTFVI-NDVI_2011
y = -1.466x + 0.365
R² = 0.481
NDVI
Urban Thermal Field Variance Index
NDVI_2011

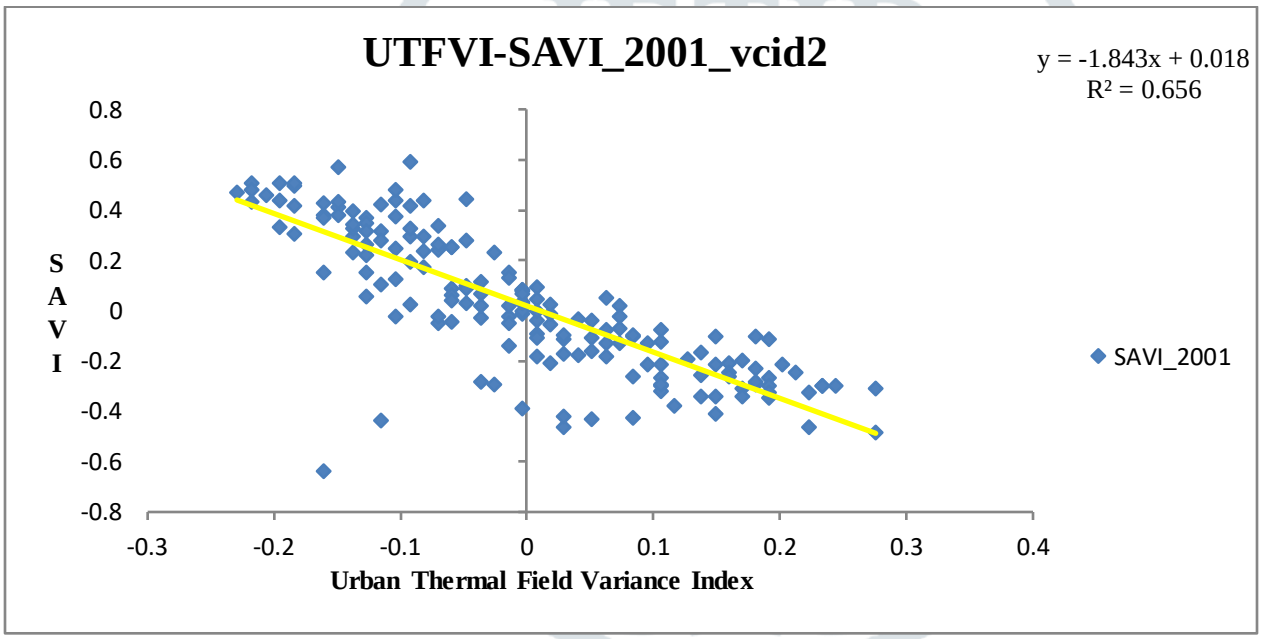

UTFVI-NDVI_2021_B10
y = -0.835x + 0.302
R² = 0.577
NDVI
Urban Thermal Field Variance Index
NDVI_2021

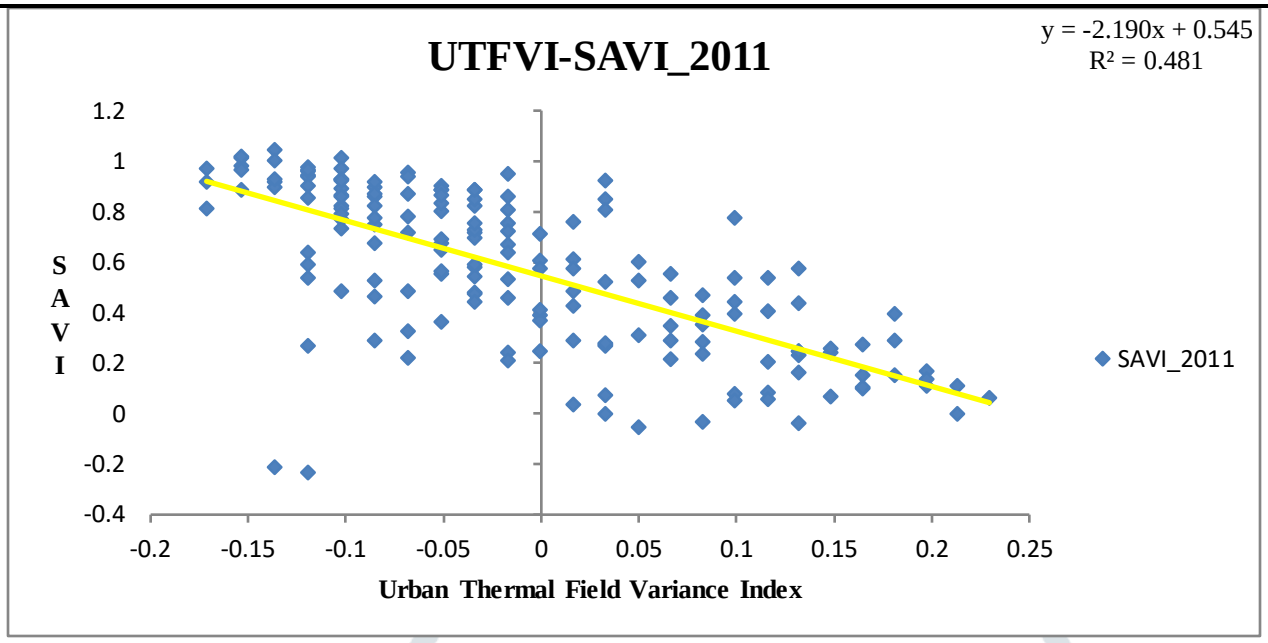


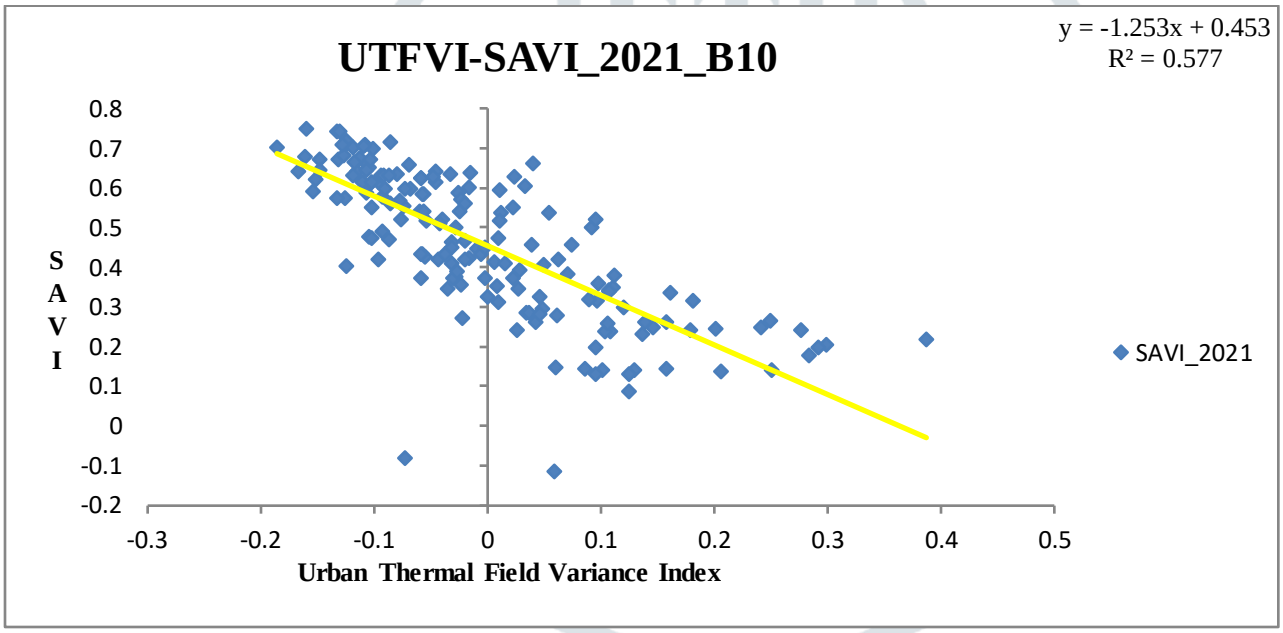
The relation between Urban Thermal Field Variance Index and Soil Adjusted Vegetation Index is given below:

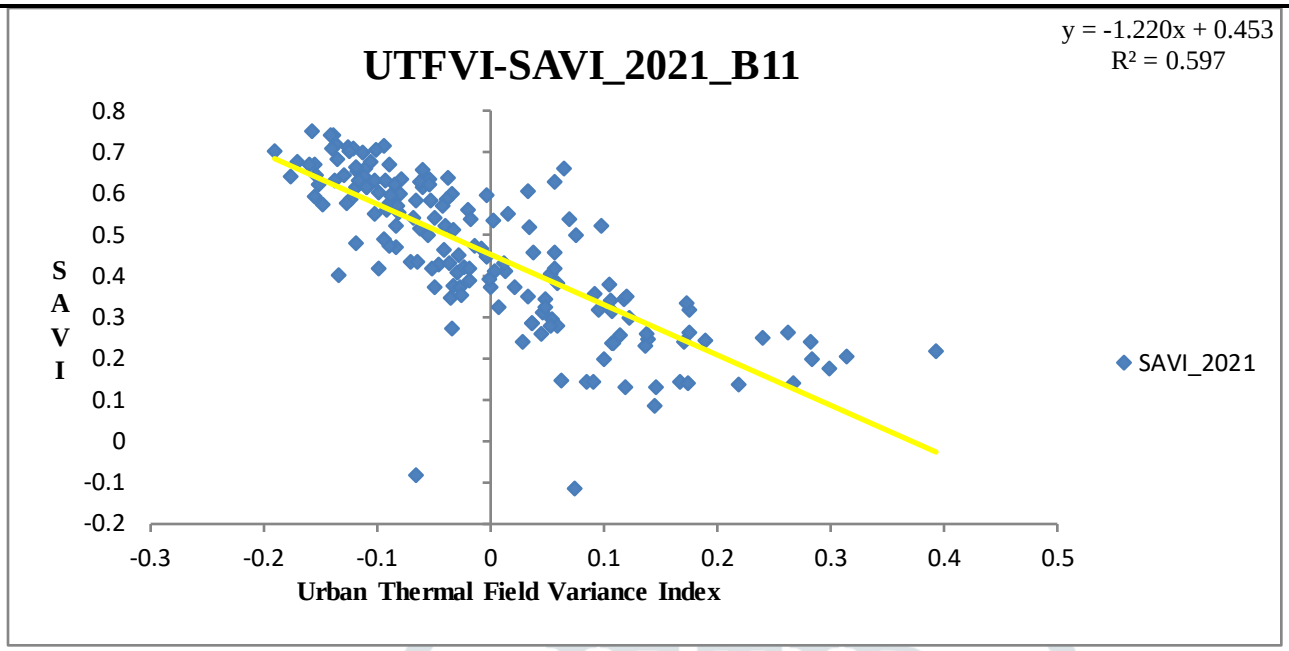



UTFVI-SAVI_2001_vcid1
y = -1.8495x + 0.0188
R² = 0.659
SAVI
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
Urban Thermal Field Variance Index
SAVI_2001


UTFVI-SAVI_2001_vcid2
y = -1.843x + 0.018
R² = 0.656
SAVI
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
Urban Thermal Field Variance Index
SAVI_2001


UTFVI-SAVI_2011
y = -2.190x + 0.545
R² = 0.481
SAVI
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.2
-0.15
-0.1
-0.05
0
0.05
0.1
0.15
0.2
0.25
Urban Thermal Field Variance Index
SAVI_2011


UTFVI-SAVI_2021_B10
y = -1.253x + 0.453
R² = 0.577
SAVI
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
Urban Thermal Field Variance Index
SAVI_2021



These results shows that the Discomfort Index which is directly proportional to the negative impact on human health is highly and positively influenced by Built-up while it highly and negatively influenced by Soil Adjusted Vegetation Index (Hanqiu Xu et al. 2017). Discomfort Index also effects by Barren Land Index, Water Index and Vegetation Index but it is negatively correlated with Water Index and Vegetation Index and positively correlated with Barren Index (N. Gupta et al. 2019; B. Roy et al. 2022). This shows that presence of water bodies and vegetation cover is good to human health while presence of barren land is not good (Z. Liu et al. 2024).

The statistical analysis between Urban Thermal Field Variance Index and Land cover indices (M.N.H. Naim et al. 2021) shows that the Urban Thermal Field is highly and negatively effects by Soil Adjusted Vegetation Index which shows that Shurb Area has very good conditions for ecological evolution. However, there is high positive correlation is found between Urban Thermal Field Variance Index and Built-up which shows that Built-up area has negative impact on ecological evolution (M.N. Minallah et al. 2023). However, Vegetation Index and Water Index are also negative correlates with Urban Thermal Field Variance Index and Barren Index is positively correlates with Urban Thermal Field Variance Index (A. Vijayakumar et al. 2023; A.K. Tiwari et al. 2024).

Discussion: The analysis between land cover indices and human discomfort & land cover indices and ecological evolution for the years 1991, 2001, 2011 and 2021 shows that Discomfort Index and Urban Thermal Field Variance Index are highly and negatively correlates by Soil Adjusted Vegetation Index (Shurb Land) and also negatively correlates by Vegetation Index and Water Index. These factors shows that there is positive effect of presence of water bodies, vegetation and shrub land on human health and ecological evolution (S. Guha 2021) and negative effect of presence of built-up and barren land on human health and ecological evolution (E.W. Chu et al. 2017; M.B. Moisa et al. 2022).

So, the sustainable development approach can be carried out by making green space (M.C. Kondo et al. 2018) and blue space (N. Smith et al. 2021) and by combination of both green and blue spaces (Kun Wang et al. 2022)

Conclusion: The analysis of relationship between Land Cover Indices- Discomfort Index and Land Cover Indices- Urban Thermal Field Variance Index of Kanpur Metropolis in Ganga-Yamuna Doab region of India shows that presence Shurb Land is very important for human health and ecological evolution and presence of Green Space and Blue Space and combination of these two improve resident's health and strengthens the Ecological Evolution and by making Blue and Green Spaces and by conserving them through resident's help we can go for urban sustainability for this region.

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Conflicts of Interest: There is no conflict of interest at all by all authors.

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