"REVIEW ON CHEMICAL PATTERN- CHANGES IN HERBS DUE TO GEOLOCATION VARIATION"

Ragunathan Muthuswamy[1*], M, Tamil Mozhi[1] R. Kamaleeshwari [1] G. Kowshika[1], Tamilvani M[2]

[1]Department of Pharmacognosy, Swamy Vivekananda College of Pharmacy, Tiruchengode, Namakkal-637205, Tamilnadu, India. (Affiliated to The Tamilnadu Dr.M.G.R. Medical University), Chennai.

[2] Department of Biotechnology, St. Michael college of engineering and technology, Madurai, Tamilnadu, India.

AUTHOR OF CORRESPONDANCE:

Dr. Ragunathan Muthuswamy

Head, Department of Pharmacognosy,

Swamy Vivekananda College of Pharmacy,

Tiruchengode, Namakkal-637205,

Tamilnadu, India

https://orcid.org/0000-0002-1782-292X

ABSTRACT:

Geographical variances significantly impact the chemical makeup of medicinal herbs, which in turn affects their pharmacological dependability and therapeutic potential. The content and diversity of phytochemicals including flavonoids, alkaloids, terpenoids, and phenolic acids are greatly influenced by variables like climate, altitude, soil type, and ecological interactions. Current research on geolocation-driven chemical diversity in medicinal plants is summarized in this review, emphasizing the value of geospatial technologies such as RFID, LIDAR, GPS, and Wi-Fi positioning systems in mapping and interpreting these differences. The paper highlights how accurate geolocation mapping and phytochemical profiling may guarantee the quality, effectiveness, and conservation of herbal resources through case studies like Gentiana rigescens. Additionally, the ability to monitor regional phytochemical dynamics and optimize agricultural techniques is

improved by the combination of machine learning and molecular technologies. In the end, this multidisciplinary strategy has the potential to improve contemporary pharmacognosy as well as traditional herbal uses.

Keywords: GPS mapping, medicinal plants, phytochemical variation, secondary metabolites, environmental variables, geolocation Gentiana rigescens, herbal medication quality, LIDAR, and ethnopharmacology

INTRODUCTION:

The chemical composition of medicinal herbs is significantly influenced by geographic variations, which impacts both their therapeutic efficacy and safety. Climate, soil composition, altitude, and local environmental conditions all have a significant impact on these plants' phytochemical profiles. This review examines the extent of these variations across multiple species and the implications for both modern pharmacology and traditional medicine with the use of specific case studies. As the primary source of therapeutic compounds in numerous civilizations, medicinal plants have been integral to human healthcare for millennia. Their efficacy is mostly due to the presence of bioactive substances such terpenoids, alkaloids, flavonoids, and phenolic acids.However, the presence and concentration of these compounds might change based on the plant's geographic origin, leading to significant differences in their medicinal properties[(1)].Field surveys and simple GPS mapping are two examples of classic geolocation techniques for medicinal plants that have proven useful but clearly lacking in accuracy, efficiency, and data integration. Additionally, this constraint is exacerbated by the lack of integration of machine learning (ML) techniques, which greatly improve the accuracy and effectiveness of geolocation procedures[(2)].Geolocation is a technique that uses geographic coordinates and mobile positioning technologies to locate, identify, and broadcast the precise location of a computer, networking device, or item of equipment[(3,4)]. Numerous mobile positioning systems rely on GNSS, A-GPS, and wireless communication, including Bluetooth, Nearfield Communication (NFC), and radio frequency (RF), as well as broadband data from cellular networks and Wi-Fi. Various scientists, agronomists, and technologists employ a number of advances each year to increase agricultural productivity while reducing environmental harm[(5)].

OVERVIEW OF GEOLOCATION:

The process of determining a device, user, or object's actual geographic location via a variety of technologies is known as geolocation. It enables applications and

services to ascertain a user's location using cellular networks, GPS, wifi signals, or IP addresses.

1.Satellite-based system
2.Cell tower triangulation
3.Wifi-position system
4.IP address-based geolocation
5.RFID and NFC- based tracking
6.Bluetooth and Beacons
7.LIDAR and Geospatial imaging

GEOLOCATION TECHNOLOGIES:

1. SATELLITE-BASED SYSTEM:

GPS Antenna:

Depending on the manufacturer and the mobile device being used, the second type of triangulation is GPS-based and has a higher accuracy. In terms of location precision, the majority of the gadgets can provide an approximate distance of 4.9 meters. When a user attempts to use GPS service on a mobile device in a near area, a very serious issue arises. The issue in this situation arises from obstacles that stand between the GPS antenna and the satellites; often, this is a large wall or a roof that significantly reduces the receiving signal. This is where businesses who use geolocation technology to enhance the customer experience are profiting from indoor location technology[(6)].

2. Cellular Network Triangulation:

From the time of the ancient Greeks, who developed geolocation by making observations by measuring the stars in the sky, to the present, when the procedure has become simpler and the measurements are made using a GPS antenna, the measurements approximate a tringle, which is why the technique is known as triangulation. Even with the GPS antenna there is a small amount of false inside the measurements which means that the location shown on the GPS is inside a small triangle. The smaller this triangle is the higher the approximation of the taken GPS signal[(7)]. Regarding a mobile phone,there are two distinct types of triangulations. The first is the triangulation of network providers, which is extremely challenging to set up. Although third parties often require a warrant from the police to use them, the sim carrier providers are in possession of them,

creating a murky situation regarding whether or not they are using them for promotions. Even when a phone is not in use, GSM carriers have the ability to locate it within three cell tower range. Due to the huge population need for GSM signals, this is easier to do in rural areas.Because of the limited accuracy of the projected position, this strategy is less useful and useless in urban areas. Therefore, an overall estimate of the proper location that can be made here ranges from hundreds of meters to a few kilometers [(8)].

3. Wifi-position system:

Terrestrial WiFi access points (APs) are used in WiFi positioning to pinpoint a location. In the last several years, a significant number of 802.11-based access points (APs) have been installed by private citizens, corporations, academic institutions, retail establishments, and public structures. Each of these APs continuously sends out a signal to the neighborhood to let others know they are there. Usually, these signals can reach hundreds of meters in all directions. Because there are so many APs in cities, the signals frequently overlap, forming a natural reference system for location determination. When a mobile device with WiFi is within range of an existing WiFi signal, WiFi positioning software determines the device's present location[(9)].For this, a number of matching methods have been created, such as support vector regression, shortest M-vertex polygon, Bayesian modeling, neural networks, kernelized distance estimation, and k-nearest neighbor estimation[(10)]. Outdoor WiFi placement can be accomplished using the same methodology as interior positioning. Although the average AP density (measured in units per km2) in metropolitan areas is significantly lower than that of an average indoor environment, AP densities in many urban areas are sufficiently high to allow signals from various APs to overlap, opening the door to the potential for a seamless WiFi-based indoor–outdoor positioning system[(11)].To put it briefly, Place Lab showed that, given the current infrastructure of 802.11 APs, it is possible to locate WiFi at a metropolitan size with a moderate level of positional precision. Although the Place Lab project was abandoned in 2005, the documentation and tools are still accessible. Numerous commercial WiFi locating solutions have since been created.

Commercial WiFi positioning system:

Some WiFi location systems, like WeFi and Navizon, depend on a user base to add WiFi signals to their database. Users are urged to log their whereabouts (either by GPS or another method) and WiFi signal readings, which are then added to a community database. Theoretically, coverage is worldwide, but in practice, it

varies depending on user contributions. In contrast, services like Skyhook Wireless, Google, and Microsoft are fully commercialized and use a fleet of data collectors in addition to data gathered by consumer devices. On the other hand, Apple only uses iPhones that customers use to gather data for its database[12].

Performance of WiFi positioning:

The performance of the current commercial WiFi locating systems at the metropolitan scale has not been well documented. The majority of peer-reviewed research on WiFi placement has been restricted to controlled indoor settings since the Place Lab project was abandoned in 2005. This stands in stark contrast to the explosive rise in the use of commercial WiFi placement at the city level[13].to ascertain how the type of device affects the variation in WiFi positioning system performance in urban settings. Despite WiFi location being widely used, no published research has examined the potential impact of device type. In this study, the same commercial WiFi location system is used on a laptop and a mobile phone. Since Skyhooks is the most well-established system to date and is accessible on a wide variety of devices, it was chosen[14].

4. IP address-based geolocation:

The process of determining an object's actual geographic location, including its latitude and longitude, is known as geolocation. IP geolocation is the process of assigning a specific, non-static Internet Protocol (IP) address to network devices based on its actual geographic location. Over the years, numerous methods have been created in response to the growing importance of identifying users' whereabouts. Their achieved accuracy varies; some can pinpoint users almost down to the street level, while others are accurate to the country level[15].

5. RFID and NFC- based tracking:

RFID is a technology that uses radio frequency (RF) to provide wireless, non-contact data transfer for identification. The core of this technology is the transmission of identification information between two devices over a radio frequency spectrum. The frequency range includes ultra high frequency (UHF) 868MHz, 915MHz, high frequency (HF), 13.56MHz, and low frequency (LF), 125 KHz-148MHz. Two devices are typically used for communication: RFID tags and RFID readers. The tags are made up of at least an antenna and an integrated circuit, and they can be passive, active, or battery-assisted passive. This is how the system operates: When an RFID tag receives an encoded radio signal from a reader asking

it questions, it responds with its identification and other details[16]. RFID tags are typically integrated into mobile devices, like ID cards, while readers are fixed. When compared to other identification systems, it offers a number of benefits, including wireless localization, a greater working distance, a faster reading speed, no battery management, and measurement precision[17-18].

6. Bluetooth and Beacons:

From the same angle, the beacon is the newest location signal technology that makes use of another feature of smartphones. Following the release of Bluetooth 4.0, BLE is a new Bluetooth technology that helps smart devices connect to one another more energy-efficiently[19]. Because cellphones can connect to beacons inside stores via Bluetooth, this is a major advantage. End users can more accurately estimate their movements and distinguish between persons moving inside a building and those moving outside of it once they are connected to these devices[20]. The ability of beacons to distinguish between signals from individuals traveling at different "height" levels is another significant benefit they provide. For many years, many retailers have used these devices that take advantage of incoming data to better understand the intentions of their customers by tracking their in-store activities with an accuracy of a few centimeters [21].

7. LIDAR and Geospatial imaging:

Any moving platform, including vehicles, trucks, trains, boats, and airplanes, can be installed flexibly with a laser-based mobile mapping system. Future research will focus on creating a small, light, and reasonably priced multifunctional mobile laser scanning system that can be quickly and easily deployed and needs the least amount of current equipment for operational support. A promising development trend would be a laser scanning platform based on a compact all-terrain vehicle or an unmanned aerial vehicle (UAV, such as balloons and helicopters) . According to mobile laser scanning in this context refers to the deployment of a laser scanning system atop a land-based vehicle.Other terminology used interchangeably in the field of laser scanning include land-based MLS, mobile LiDAR, and terrestrial mobile laser scanning (TMLS) [22].Few stan dards have been produced when employing mobile LiDAR to conduct road inspections along the route corridor, despite the fact that it has been commercially accessible for ten years. Therefore, a uniform set of guidelines is desperately needed in the near future to standardize the use of mobile LiDAR by transportation agencies. For a variety of applications pertaining to road inventories, standards and best practices will be defined and established, including control requirements, accuracy standards, data

interoperability and administration, and data quality demands of particular applications. Therefore, while employing mobile LiDAR technology for road inventory, skilled geomatics staff can be included at every stage[23].

SCIENTIFIC AND ANALYTICAL FOCUS :

1. Phytochemical Dynamics Driven by Geospatial Variables:

The richness and quantity of the specialized metabolites that vegetation produces are referred to as phytochemical diversity. As a crucial component of plant functional diversity, it influences ecosystem functioning[24], plant fitness[25], and human services [26]. Chemical ecologists continue to have difficulty comprehending the evolutionary genesis of phytochemical diversity and how it varies throughout ecosystems, despite its importance[27]. Of the >300,000 phytochemicals that are now known to exist[28] , only a small portion have been linked to a recognized ecological function or activity [29]. This is due to the fact that the majority of identification work has been done on model organisms, namely agricultural plants [30]and because, up until now, drug discovery initiatives have relied on random sampling or previous ethnomedical knowledge rather than systematic sampling from the tree of life[31] or information that is ecologically relevant[32]. The complete range and function of phytochemicals in the landscape may be revealed, and drug development research may be guided, if it were possible to more accurately anticipate the abundance and diversity of phytochemicals of relevance from phylogenetic data or from certain habitat types or conditions[33]. Furthermore, recording landscape variability in phytochemical diversity is especially crucial when considering land use change, which is leading to the loss of plants of unknown scientific and medical importance[34].The metabolome of plants has both specialized functions linked to particular lineages or conditions and fundamental processes that are anticipated to be maintained across species [25]. Therefore, a combination of ecological[35,36] and evolutionary[37,38] restrictions is anticipated to give rise to phytochemical variation in the landscape. According to macroevolution, certain types of phytochemical substances are unique to plant clades (for example, tropane alkaloids in Solanales or glucosinolates in Brassicaceae; [39]. It is believed that coevolutionary dynamics with herbivores, followed by improvements in chemical defense, are what cause such lineage-dependent diversity [40,41]. Specifically, in response to biotic pressure, plant lineages diversify by producing new, more complex, or potent chemical combinations, according to the escape-and-radiate paradigm [38,42].Thus, higher levels of phytochemical diversity are expected to have evolved in plant lineages that have undergone more evolutionary split events[38]. From an ecological standpoint, plant adaptation to biotic and abiotic

factors—both of which differ along ecological gradients in landscapes—should lead to phytochemical diversity [24,43]. For instance, it may be anticipated that selection will favor strong chemical defense mechanisms that lessen tissue loss in situations that place restrictions on plant growth, such as cold and resource-poor settings [44]. However, it is also known that diseases and herbivores can encourage divergent selection among plant congeners, which increases chemical dissimilarity.Therefore, species relatedness by itself is not a good indicator of phytochemical diversity at the site level. Here, we asked if the ecological and evolutionary variability seen in the landscape could be used to predict phytochemical diversity. Our hypothesis was that the variety of phytochemicals is influenced by trophic, climatic, edaphic, and topographic variation, in addition to the diversity of local plant species[45].

2.Geographic Determinants of Herbal Composition:

Many nations around the world continue to employ natural drugs, such as concoctions made from medicinal herbs. They have less negative effects on the human body and are thought to be safer than manufactured medications. Certain medicinal herbs have high concentrations of flavonoids, also referred to as antioxidant chemicals, which have a variety of positive benefits on human health [46-50]. Medicinal plants can also be a common supply of important elements, except flavonoids, which are secondary metabolites in the plant kingdom[51-56] . As co-factors of enzymes, these elements - particularly metals - play a crucial role in the metabolic processes of living things by taking part in significant biochemical changes[57] .The usage of therapeutic herbs is particularly common throughout Eastern Europe. People in Ukraine, Lithuania, Poland, Belarus, Serbia, Bulgaria, and Romania frequently gather medicinal plants from the wild and make their own herbal teas, infusions, or decoctions to treat a variety of ailments, including the common cold, nausea, and nervousness. Natural drugs have fewer side effects, and the complex of secondary metabolites that they contain, along with a variety of macro- and micro-elements, contribute to their positive effects on the human body. Numerous research have examined the amount of flavonoids and the concentration of key components in herbal medications[58-61] .Using spectroscopic and chromatographic methods, the essential components and their relationships to phenolic compounds in medicinal plant infusions from many European countries (Lithuania, Serbia, Italy, and Portugal) were carefully examined. It was discovered that, although coming from far-off places, therapeutic plant infusions varied greatly and were highly influenced by the type of plant [56]. However, it was discovered that there is no discernible effect of geographic origin on element levels when the elemental composition of flavonoid-rich herbs from Poland, Lithuania,

and Serbia was studied using ICP-OES (inductively coupled plasma–optical emission spectrometry) and LIBS (laserinduced breakdown spectroscopy) techniques[58] .The elements contents of various Salvia officinalis species, on the other hand, were shown to vary significantly between species and within a single species, with a significant dependence on the location of collections [59]. A number of factors, including the total phenolic and flavonoid concentration, were examined in the seeds and aerial portions of Trigonella monspeliaca, a medicinal plant that is frequently grown in the Mediterranean region. According to this study, the aerial portion of the plant under investigation had a high level of total flavonoids, but the seed extract had noticeably higher amount of total phenolics[60].Potassium was the most prevalent element in lemon grass, while copper was the least, according to other researchers who looked into antioxidant activity as well as the elemental, phenolic, and flavonoid contents . Furthermore, there were notable regional variations in the concentrations of the eight components under study to see whether there are any similarities or differences between the quantities of particular essential components and total flavonoids. As a result, the amounts of Fe, Mn, Zn, and Cu were determined in both their aqueous infusions and the digests prepared from nine different botanical plant samples. The purpose of the study was accomplished through the use of multivariate statistical techniques[61].

3.Impact of Altitude and Climate on Plant Bioactivity:

Primary and secondary metabolites are two categories into which plant metabolism can be separated. All living things have primary metabolites, which are necessary for their growth, development, and reproduction. Secondary metabolites, on the other hand, are only present incidentally as byproducts of primary metabolites[62] and serve a number of vital purposes, such as facilitating the plant's interaction with its surroundings[62]. Numerous prior studies have reported that a number of environmental factors, including temperature, altitude, precipitation, solar radiation levels, and harvest season, may have an impact on the biosynthesis and accumulation of plant metabolites [64-66]. By altering the chemical makeup of various plant species and most likely their biological activity as well, environmental influences may diversity the quantity and quality of production[67] .Plant cells may experience oxidative stress as a result of their metabolic pathways' sensitivity to changing environmental conditions, which would change their metabolic activity [68]. However, through the phenomenon of cross-tolerance, which involves a variety of mechanisms to adapt to the constantly changing environments, plant cells exhibit an extremely intriguing ability to modify their physiology and metabolism in response to a single type of biotic and abiotic environmental variables, or both[69]. One of the main climatic factors that

might affect the composition of a plant's primary and secondary metabolites is temperature. Different plant species, cultivars, and genotypes have different ideal temperature ranges for optimal physiological processes, including metabolite biosynthesis. Therefore, any departure from such parameters may have an impact on the biomass of metabolites [(70)].By raising the soil's water content, precipitation also offers the most important and fundamental environmental component that affects plant development and production, much as temperature[(71)]. This increases the creation of phytoconstituents. Numerous studies have nevertheless demonstrated that low precipitation, which is usually associated with drought, alters the pathways of biosynthetic metabolites and permits the synthesis of more secondary metabolites as a reaction and defense mechanism against the stressor [(72-74)]. A decrease in air temperature, total atmospheric pressure, and an increase in precipitation and UV radiation from incoming solar radiation are all caused by altitude, which is also thought to be the binding factor that connects the previous environmental factors. These effects can be either positive[(75)]or negative [(76)].The physiology of the plant influences the kind and amount of bioactive compounds.

4.Case Studies of Regional Variability in Medicinal Herbs:

The main medicinal portions of Radix Gentianae, a plant used in traditional Chinese medicine (TCM), are the roots and rhizomes. The Yunnan Province of China is the actual producing zone for the Gentiana rigescens Franch, also known as daodi in Chinese. The medications made here are of greater quality and have better therapeutic results than those made from the same species in other regions.The primary active components of G. rigescens are the iridoids gentiopicroside (GE), swertiamarin (ST), and sweroside (SW). The liver-protecting properties of G. rigescens.They have long been used to treat inflammation, damp heat, jaundice, eczema, and itching [(77,78)].They also have cholagogic, anti-inflammatory[(79)] and antioxidant[(80)] properties.Radix Gentiana root has been identified as a possible material for a functional diet against Alzheimer's disease (AD) in recent years due to the presence of 2,3-dihydroxybenzoates (gentisides A-B) with positive neurotrophic and protective effects[(81)]. G. rigescens is a significant natural remedy that is utilized in clinical therapy as well as as a raw material for Chinese medications like "Long Dan Xie Gan Tang." G. rigescens is therefore a type of plant with exceptional physiological activity that has proven to be very useful in the creation and application of medicinal plant resources. The yearly demand for G. rigescens in the clinical and health care product industries can reach 40–60 tons due to the recent expansion of research.Additionally, the associated quality standard has been enhanced[(82)]. Consequently, the growing demand for G. rigescens exceeds the capacity of wild resources, potentially leading to resource

depletion issues.To prevent the original plants from going extinct as a result of increasing demand and overharvesting, advancements in artificial culture technologies have been made recently[83].However, thecareless introduction without taking ecological compatibility into account also leads to a number of issues, including the significantly elevated levels of heavy metals in therapeutic materials and the inconsistent quality of materials produced from various sources.As a result, more research into the quality and geographic origin of wild G. rigescens is required. Due to its benefits of speed and non-invasiveness, vibration spectroscopy technologyincluding Fourier transform infrared spectroscopy (FT-IR)has become a popular method for evaluating quality[84]. Furthermore, when compared to the data from high performance liquid chromatographs (HPLCs), the acquired spectra show all of the chemical information from the sample. In order to better estimate the true geographical origin, multivariate analysis is typically used to mine the spectrum information. Additionally, nonlinear support vector machines (SVM) and linear partial least squares discriminant analysis (PLS-DA) have been widely utilized. When assessing the quality of Chinese medicinal materials, the active components of medicinal plants are crucial indicators[85]. For most plants, the accumulation of secondary metabolites is influenced by ecological ambient elements such light, water, temperature, and soil moisture in addition to their own genetic traits [85,86]. Depending on changes in their own environment, plants will choose which species and how much of secondary metabolites to synthesis[87]. This can be attributed to the combined effect of plants' evolutionary selection and long-term adaptation to complex habitats, as well as their environmental choices [88].Yunnan Province, the primary G. rigescens production region, has a unique low-latitude plateau geographical environment. The distribution area has a range of climate types, from north subtropical to south subtropical and marginal tropics[89].Currently, a lot of research has concentrated on examining the variations and similarities of medicinal materials gathered from different climate zones, ignoring the impact of environmental conditions on medicinal plant variety[90].Furthermore, additional elements that are frequently overlooked include the cumulative temperature and severe temperatures that are tracked and identified in Yunnan Province's several climate zones. Exploring the relationship between environmental conditions and the therapeutic material should therefore be a priority. Enhancing the quality of medicinal materials, standardizing the production of medicinal plants from G. rigescens, and safeguarding wild resources are all very important[91].

Precision Mapping of Phytochemical Markers via GPS :

Genetic diversity in plant species provides vital information on their capacity to cope with diferent environmental stresses[92] because domestication and the evolution of crops reduce the diversity of crop species. Increased genetic variation improves the chances of efective plant selection, making it an essential component in utilization by evaluating its scope and range[93,94]. Diferent approaches have been used to determine genetic polymorphism in many plant species. Recently, estimating genetic diversity and deciphering genetic composition have both benefted greatly from the use of molecular markers, identifying the genes implicated in critical growth mechanisms and conserving genetic variation[95]. To better estimate genetic diversity, molecular techniques have been used in tandem with morphological variations. In medicinal and aromatic plants, the chemical composition assessment of secondary metabolites provide an additional source of important information[96,97] .Both the distribution of genes between populations and the range of possible variations within a species in addition life history criteria, population size, breeding system, pollinators, and phylogenetic position must be considered in order to comprehend genetic variation[98,99]. The genetic diversity of both wild and cultivated species of the Cucurbitaceae was assessed using morphological and agronomical traits and isozymes polymorphism[100,101], reported that multiple whole-genome duplications and important morphological and molecular variations enhanced genetic diversity preceding polyploidizations in the Cucurbitaceae. These fndings established a phylogenetic framework for the family Cucurbitaceae and revealed novel information about the morphological and genetic changes underlying the family’s adaptive evolution. Wax gourds (Benincasa hispida) are a cucurbit plant with fruits that can reach lengths of 80 cm and weigh more than 20 kg[102]addressed the genetic diversity in Cucurbitaceae by identifying many genome parts and genes that could have been chosen during domestication and likely led to the large fruit size.

APPLICATION:

1. NAVIGATION AND MAPPING:

Global positioning system navigation-enabled devices use satellites to pinpoint a user's precise location and deliver real-time directions, and GPS-based applications like Google Maps and Waze use geolocation to offer real-time navigation, traffic updates, and route optimization[103].In order to deliver real-time congestion updates, real-time traffic uses sensors, crowdsourcing reports, and historical data[104].

2. WEATHER FORECASTING:

Weather apps such as Accuweather and the Weather Channel can deliver hyperlocal forecasts thanks to geolocation. It offers real-time location-based weather updates and hyperlocal weather forecasting. Global weather patterns, storms, and climate changes are tracked via satellite-based weather monitoring. Hurricanes, tornadoes, tsunamis, and wildfires are examples of severe weather alerts and disasters[105].

3. MARKETING &ADVERTISING:

Businesses can use geo-fencing to send location-based push notifications and advertisements to users' smartphones. When a user enters a virtual border that is created around a specific location, a notification is sent and the user is notified. Additionally, it uses Bluetooth beacons to identify nearby clients and deliver tailored offers[106].

4. KEY CLIMATIC PARAMETERS MONITORED :

In the UTLS, atmospheric profiles of temperature, pressure, geopotential height, bending angle, and refractivity are obtained with high accuracy (<1 K) and vertical resolution (0.5 km to 1 km)[107].

- Temperature variations
- Precipitation patterns
- Sea level changes
- Glacial and ice sheet melting
- Vegetation and land use changes
- Extreme weather events tracking[108].

CHALLENGES AND LIMITATIONS:

Accuracy and precision issues:

There may be errors in location data, including reversed latitude and longitude values, missing negative signs, and, in certain situations, missing data, according to the data and information that the geolocation app retrieves and that the end users (farmers) supply. Nevertheless, using GNSS is not difficult[109]. GNSS reliability, accuracy, and accessibility are essential, especially for applications requiring

precise and crucial location. Nevertheless, space communications are poor and sometimes hindered, disrupted, or harmed by a number of other issues[110].

High cost technology and infrastructure:

The HD map is essential for self-driving cars. It is widely acknowledged that ultra-high (centimeter-level or higher) resolution and centimeter-level accuracy are necessary for HD maps. As a result, making HD maps is difficult. The current HD maps are created and updated using specialized vehicles that are outfitted with advanced LiDAR, cameras, RADARs, GNSS, and INS. For instance, Baidu used million-dollar mapping trucks to create an HD map of a Beijing park over the course of five days (Synced 2018). Such a generation approach is expensive, and it is challenging to continuously update an HD map[111].

Policy and ethical concerns:

Since several governments and organizations limit access to climate-related geospatial data, data accessibility and sharing continue to be difficult.Concerns about possible abuse and the use of geolocation data for surveillance raise ethical issues[112].

CONCLUSION:

A complex interaction of ecological, genetic, and environmental factors shapes the bioactivity and chemical integrity of medicinal plants, which are intrinsically linked to their geographic origins. When combined with genetic and phytochemical studies, this review shows that sophisticated geolocation technologies offer a potent way to map and comprehend this spatial heterogeneity. Precise geographic mapping helps to protect endangered species, encourage sustainable harvesting and production, and support the standardization of herbal quality. Notwithstanding present obstacles such as the expense of technology, accuracy constraints, and data ethics geolocation has enormous potential to transform the way we evaluate and apply plant-based medications. Future advancements in herbal therapy will depend on closing the gap between conventional wisdom and technological innovation to guarantee therapeutic dependability, safety, and consistency.

Acknowledgement:
Heartfelt thanks to all my friends in the Swamy vivekanandha college of Pharmacy-Tiruchengode, Namakkal, Tamilnadu, India.

Conflict of interest:
We declare that we have no conflict of interest.

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