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Hypothesis

Maximising the Edges of Natural and Human Systems: The Case for Sociotones

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Abstract: In many fields of fundamental and applied ecology, the transition or edge between two distinct biological communities is known as 'ecotone'. The ecotone concept was first introduced in the early 20th century, describing the edge between two ecological systems which disappear in a transition zone but in opposite directions. This paper examines the evolution of the concept and its different applications over time. It explores the characteristics of ecotones as biodiverse enriched ecological niches occurring at multiple spatial scales. The paper goes further by proposing the concept of sociotone or social systems in tension, first by postulating a series of principles through which many possible interpretations may arise and secondly, by describing the societal interface where diverse worldviews, intentions and experiences meet. The concept is tested against a territory of social tensions between newcomers and stakeholders in Sicily providing evidence of a field of dynamic socio-economic transformations and prospects. The paper concludes by positioning sociotone as a possible framework to realise the systemic potential of multicultural globalised societies.

Keywords: ecotone; sociotone; regeneration; diversity; serendipity; bisociation

1. Introduction

In many fields of fundamental and applied ecology, the transition or edge between two distinct biological communities is known as 'ecotone'. The word is a linguistic blend derived from the Greek eco—'oikos' or environment, and tone—'tonos' or tension, meaning a place of high intensity where ecologies are in tension. The ecotone concept was first used by Clements, describing the edge between two ecological systems which disappear in a transition zone but in opposite directions [1]. This could be, for example, a marshland between river and riverbank [2], the transition zone between forest and grassland [3] or even the transition between continental scale biomes [4].

Typically, there is more biodiversity on the edges than on either of the ecosystems themselves [5]. Mollison claims ecotones tend to be 'species-rich' [6] (p. 77), as they benefit from inputs and resources from both environments, providing unique ecological niches manifested in space and time. This is supported by the interspersion hypothesis proposed by Leopold, which recognises a greater abundance of game species along habitat edges, suggesting wildlife managers to develop as much edge as possible when considering wildlife conservation [7]. However, it is believed that while ecotones provide zone opportunities for edge organisms, they also offer harsh conditions for interior organisms [8]. Mollison illustrated the concept of edge diversity through a pair of diagrams, labelled Crenellated Pond Edge as seen in Figure 1, demonstrating how, by increasing the terrestrial and aquatic interface of the pond, new niches are created, therefore expanding the area for other species (e.g., blueberries, frogs, insects) [6].

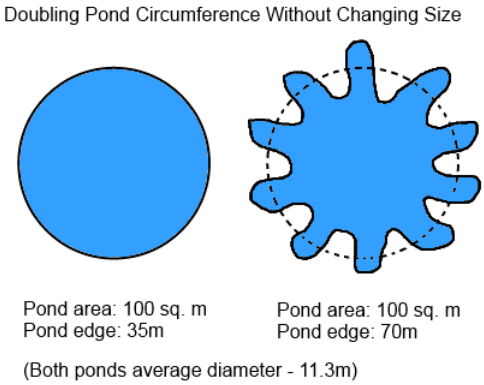

Figure 1. Crenellated Pond Edge [6].

Ecotones can naturally self-organise and evolve through space and time, and can be enhanced by human intervention through farming, forestry [9], conservation [7], urbanisation and regeneration. Senft [10] argues that most studies in the field of ecotones have failed to address several factors determining the diversity of ecotones, such as environmental heterogeneity and invasive species spread, while McConnell et al. [11] question the seemingly simplistically universal application of the concept.

Ecotones exist at different spatial scales [4] with an overlapping area of varying width, not larger than the adjoining communities [3] and rarely defined by sharp lines [1]. Ecotones can shift location and grow weaker or stronger [10], and above a certain density, they become redundant and may have a negative effect by fragmenting the habitat [12]. Table 1 demonstrates the "limited interactions possible" [6] (p. 79) when two systems merge into an ecotone.

Table 1. Possible interactions when two systems merge into an ecotone, by Morrison [6].

	System A	System B
No difference in stability, yields or growth	0	0
One system benefits at the expense of the other	+	-
One system benefits at the expense of the other	-	+
Both systems benefit	+	+
Both are decreased in vitality	-	-
One system benefits, the other is unaffected	+	0
One system benefits, the other is unaffected	0	+
One is decreased the other is unaffected	-	0
One is decreased the other is unaffected	0	-

Ecotones are stochastic, unstable ecological zones [13] characterised by instability due to the sensitivity to environmental changes [14] and the reaction between the adjacent zones [6]. The meeting place between ecotonal communities often acts as nets or sieves for resources [6] such as humus and seeds, creating beneficial accumulations. This enrichment at the juncture between communities is known as the edge effect [3]. For ecological designers, pursuing the edge effect means taking advantage of the natural ecotone phenomenon [15] using the naturally occurring turbulence, trade and accumulations of the edge to work for greater diversity [6] and increased system productivity and stability [16].

2. Materials and Methods

Based on the above review, this paper is the first attempt to describe 'sociotone', or social systems in tension, as a new concept to be applied in multicultural societies with the following working hypothesis:

> *Just as it is possible to maximise the edges, diversity and productivity between neighbouring biological communities, so it is possible to create a more significant edge effect in society between different social groupings with diverse worldviews, power structures and intentions.*

The paper adopts a case study approach to check the validity and relevance of the concept. However, as a proposed research, it does not generalise the analysis of the circumscribed case to a larger sample. Instead, the social analogue to ecotones aims to provide a framework for new discourses influencing social life [17], which can lead to understanding complex wholes [18]. Using pattern language [19] and regenerative thinking [18] as the framing of the sociotone hypothesis, a dialogue with the natural world is intentionally established. Grounded on the integral and interdependent nature of living systems—social and biotic [20], the paper lays down a series of principles informing the sociotone principle through which many possible interpretations may arise.

2.1. A Sociotone is a Field of Increased Diversity

Diversity in nature is defined as the number of different elements within a specific system [6]. In the context of the living world, the concept does not refer to the functional synergistic or antagonistic relationships between the components which can enhance or deplete the self-regulating capacity and resilience of a system. For Mollison, great diversity may create chaos or confusion, whereas multiple functions can bring order and trigger resourcefulness [6]. Leslie and McCabe go further and suggest that when a specific ecosystem is impacted by change, the diversity of responses originated by the different elements can strongly influence the overall resilience of the ecosystem [21].

In society, diversity is described as "all the ways in which we differ" [22] (p. 3). There are endless ways through which we differ along the dimensions of race, ethnicity, gender, sexual orientation, socio-economic status, age, physical abilities and belief systems. As depicted in Figure 2, the United Nations (UN) advocates the need to cultivate a dual awareness of diversity embracing both the explicit realm above the water line and the unconscious and less obvious territory of values, thought patterns and worldviews [23].

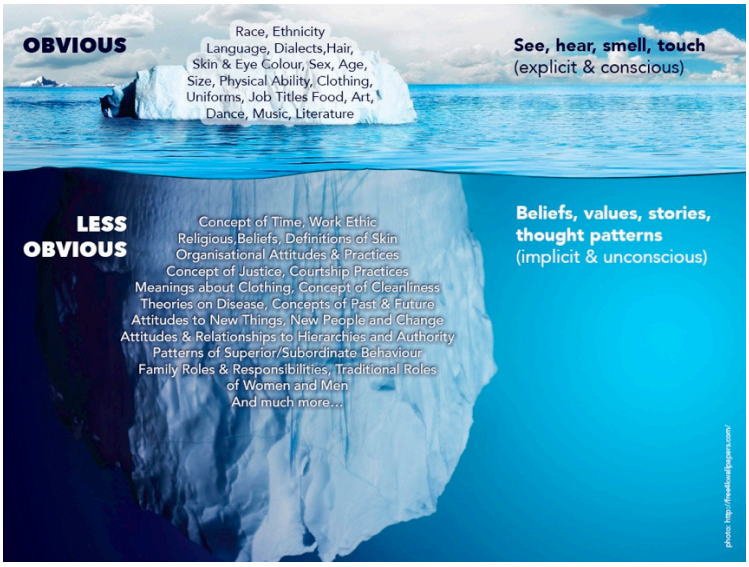

Figure 2. United Nations (UN) diversity iceberg [23].

Due to the pace of migratory flows, urban cultures in Europe are undergoing accelerated changes in new forms of diversity [24]. Cities, and in fact whole regions, are increasingly becoming 'fractals' [25],

with parts taking on the characteristics of the whole. Thus, sociotonal edges are expanding from where a whole range of welcoming signals are experienced by residents and newcomers with the promise of social interaction [26] or reaction. From asset to threat, diversity is translated into social enrichment in cultures that recognise and accept social difference [27] and see society as an endless meeting [28]. When hegemonic approaches attempt to suppress the expression of social groups, varying intensities of social conflicts erupt [29].

2.2. A Sociotone is Part of the Whole and Evolves as the Whole Evolves

Life unfolds in a continuum of emergence, vitality, peak, plateau, decay and transformation. All stages unfold through an unbroken movement of existence [30] and essence [18]. Each stage in itself constitutes a whole within a whole, manifested through interdependent nested systems endlessly changing, cycling, evolving and building to higher levels of complexity [31].

For Alexander, the task of creating wholeness in the city can only be achieved through a process, not a projected designed form [19]. If the process fails to produce wholeness, citizens suffer right away. Similarly, the process through which a sociotone evolves contributes to the salutogenic state [32] of the proximate and the greater wholes [33]. In this context, this paper adopts a Heideggerian perspective and positions sociotone as an entity that is defined by its 'web of relations forming the context within which the entity is meaningful' [34]. Therefore, a key design question for 'edge interventions' is how social edges could continuously improve the value being created for the system as an undivided whole [30], moving systems up to higher orders of expression [33] and meaning [34].

2.3. Sociotones Range from High Incompatibility to Adaptability

In ecological systems, stability is achieved through interventions that enhance the beneficial connections between the components. Sometimes, those connections are as incompatible as a chicken and a fox [6]. Sometimes the companionship between plants such as tomato and basil can enhance flavour, productivity and pest control [35]. Moreover, although "true incompatibility may be rare" [6] (p. 32), ecological designers trained in regenerative development aim to introduce companionable components in the edge zone to increase the vitality and viability of the systems [33].

Putnam proposes that social compatibility and trust tends to be hindered in a society that displays high cultural diversity [36]. Based on studies of North American society, he argues in the short and medium terms, increases in ethnic diversity triggers social isolation and avoidance of engagement with local communities [36]. As presented in Table 2, sociotone theory goes further and proposes that when diversity in social relations reaches a tipping point, it tends to attract even further diversity in complex mosaics of life-enhancing scenarios of adaptability.

Table 2. Comparing contrasting Putnam and sociotone approaches to compatibility (by Author).

Level of Hegemony	Level of Diversity	Compatibility	
+	-	+	Putnam perspective
-	+	-	Putnam perspective
-	++	+++	Sociotone proposition

Note: + refers to increased levels, while - refers to reduced levels.

Stress in natural systems often occurs due to impermeable membranes [6]. By mimicking nature, sociotones can expand their permeable boundaries of caring [37], allowing inspiration and perspiration of the adjacent fields in the linked system, while shaping and re-shaping identities of social actors in the process [38]. Thus, the principle of a tipping point of diversity unleashing higher social compatibility should be checked against multicultural territories enriching heterogeneous urban environments [39].

2.4. Sociotones Manifest High Levels of Uncertainty and Choice

Mathematical theorist Shannon investigated the relationship between a number of events and the level of uncertainty in the system, suggesting that as sources of information increase equally, more choice or uncertainty occur [40]. The post-positivist uncertainty reduction theory argues that information about the other party reduces behavioural and cognitive uncertainty and is critical in the development of social relationships [41]. For Berger and Calabrese, dissimilarities between subjects produce increased uncertainty due to the increased number of potential alternative behaviours [41]. Sociotones are information- and communication-rich fields, therefore, manifesting a high state of uncertainty and choice.

In ecological literature, we find a similar relationship. In highly diverse natural systems, an unknown unit could belong to any species, leading to a high uncertainty in the prediction of its identity [42]. Likewise, in social systems with a high level of ethnic and social heterogeneity, when the range of potential linkages between identities increase, solidarity decreases [36] and higher orders of uncertainty increase.

Potential dwells in the field of sociotonal uncertainty, offering a myriad of interactions and choices. Like living systems, potential is anchored in a territory and is actualised in nested ways [33]. Drawing from a nature–culture parallel, this paper investigates ways through which young women arriving from Nigeria may harness potential within social edges as a source of collective motivation [33] for territorial regenerative development.

2.5. Sociotones Offer the Prospect of Serendipity and Innovation

Historically, the term serendipity coined by English novelist Horace Walpole has been used to describe the accidental discovery of something valuable [43]. Serendipity tends to create "unexpected brilliant results" [44] (p. 1) deriving from a combination of "effort and luck joined by alertness and flexibility" [45] (p. 978) while looking for one thing and finding another [43].

Social edges are incredibly dynamic and complex fields. Their multifaceted make-up of patterns nested within patterns interwoven in families, guilds and social relationships [31] provides a 'pregnant' field for serendipitous observation and discovery. Where multiple intersections occur, processes of creative breakthrough are instigated [46], and innovation emerges.

The potential of accidental discoveries within a sociotone is heightened by the attitude of observers inhabiting its field. Merton and Barber describe this as "what the observer brings to the datum rather than the datum to itself" [43] (p. 171). Melo argues the importance of a prepared mind as a condition to trigger a serendipitous experience, as making something from the unexpected is more a question of enactment than of luck [46].

Bisociation practice is a catalyst for serendipity to happen. The term bisociation involves connecting two seemingly unrelated things into a new matrix of meaning [47]. Bisociation provides the ground for metaphoric thinking and happens when we think in multiple planes and bring together two ideas or things that seem to have nothing in common. Figure 3 offers a depiction of bisociation in which two reversed conceptual planes and unrelated mind processes meet, generating discoveries and synthesis.

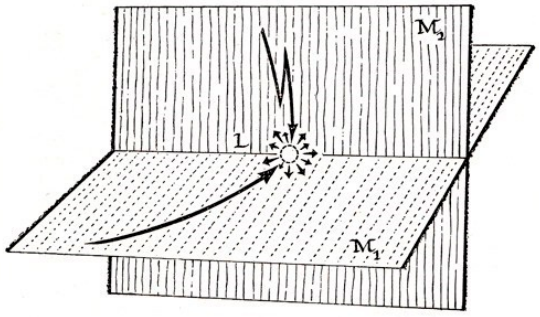

Figure 3. Matrix of new meaning when two unrelated things are bisociated, by Koestler [47].

Thus, those who are engaged in sociotone work may adopt an attitude of curiosity and alertness with minds stocked with everything but prejudices [43], so that the chances of accidental discovery fostering new matrices of meaning may increase.

3. Results

3.1. The Context

According to the United Nations High Commissioner for Refugees (UNCHR), the world today is marked by the highest levels of human mobility on record [48]. An unprecedented 70.8 million people worldwide have been forced from home for humanitarian, political, social, economic, environmental and, most recently, for climate reasons [49]. Among them, there are nearly 25.9 million refugees, over half of whom are under the age of 18 [48]. The scale of displacement worldwide has tested the limits of the international protection regime built around the 1951 Geneva Refugee Convention, which has defined the term 'refugee' as someone fleeing a well-founded fear of persecution due to race, religion, nationality, membership in a particular social group or political opinion [50].

Due to the ecotonal geographic nature of Sicily since the aftermath of the so-called 'Arab Spring', roughly 400,000 migrants have crossed the Mediterranean and landed in southern Italy, and, in particular, in Sicily [51]. For instance, between April 2015 and March 2016, when migration flows to the Mediterranean reached its peak, Sicily was the second most active post of disembarkation of the region after Greece [52]. The majority of the arrivals were young African men and women originating from West Africa and the Horn of Africa [53].

Despite the distinct legal categories between refugees and other migrants, identified as those who choose to move across international borders, individuals have complex and overlapping motivations for leaving their countries of origin [54], making it complex to be categorized. That is the case of a specific flow of Nigerian women and girls arriving by sea in Italy as potential victims of trafficking for sexual exploitation in Italy or other countries of the European Union [53]. A 2017 report by the International Organization for Migration (IOM), estimated an increase of 80 percent of Nigerian women travelling via the Central Mediterranean route with 1454 arrivals in 2014 compared to 11,009 in 2016 [53]. Countless testimonies reveal many are misled into believing they would find good jobs but ended up trapped in 'connection' houses run by criminal gangs.

Propelled by the promise of a new chapter in their lives and transported across international borders through the Sahara Desert to destinations in Libya, soon they find themselves under life-threatening conditions, informed by fear, extortion and rape [55], with a consequent increase in cases of women arriving in Italy pregnant [53] and suffering from psychological distress [55]. Furthermore, IOM declares that under trafficker's instructions, on arrival in Italy, many of the youth deceptively claim adulthood to stay away from child protection migrant regulations [53]. Thus, the current sociotone experiment in Sicily was designed to support the socio-economic integration of young female migrants, particularly those coming from Nigeria, arriving in one of the most diverse regions of Europe in terms of medicinal and aromatic herbs [56].

Lying at the intersection of trade routes, Sicily has always been a crossroads of cultures and agriculture [57]. Considered a global biodiversity hotspot due to the extent of flora and fauna variety [58], it has the largest surface (3030 km^2) of fertile organic land and the highest number of organic operators (9888 producers/processors) in Italy [59]. In ancient times, the vine and the olive tree of Sicily were the most valued crops [57]. Under the influence of Rome, Sicily became the wheat granary of the empire [60]. During Spanish rule, the Aztec Xocolatl chocolate arrived in Modica. More recently, the island has assumed the role of the garden of Europe, with its mineral-rich soils and unique fruit, herbal and vegetable products: the oranges of Catania, the lemons of Syracuse, the grapes of Canicatti, the pistachios of Bronte and the herbs of the Hyblaean mountains.

In terms of economic development, Sicily trails behind the national and European economy [61], with the GDP corresponding to 60% of the EU average [62] and a 60% unemployment growth over the

period 2009–16 [61]. With one of the highest unemployment rates in Europe, due to labour policies, intense migration and demographic trends [63], Sicily has limited integration services and labour market capacity to absorb the unplanned, fast-changing and unevenly distributed continuous flows of young migrant jobseekers [57].

3.2. Case Study

The current sociotone intervention emerged from a series of interventions conducted by the Sicilia Integra think-thank [64] aiming to support the socio-economic integration of migrants through agro-ecology capacity-building activities while diversifying the production and commercialisation of Sicilian organic products in European markets [57]. It adopted a locally led, beyond 'care and maintenance' humanitarian response condemned for leaving refugees and migrants 'warehoused' for long periods while disregarding long-term, sustainable solutions [65].

Considering that in natural systems, stress often occurs due to impermeable boundaries [6], the intervention was developed to maximise the permeability of the socio-economic edges between young female migrants, welcome migrant centres, farmers cooperatives, educational institutions, migrant non-governmental organisations and European ethical businesses. At the inception, it aimed to unleash the potential of the web of relations within the Hyblaean territory as illustrated in Figure 4 to foster the professionalisation of the young migrants, towards the creation of job opportunities contributing to the region's economic vitality.

Figure 4. Youthful Herbal Chocolate Project stakeholders map (by author).

Education plays a critical role in the integration of migrants in their new countries and cultures [66]. The sociotone intervention was conceived as a project-based learning (PBL) intervention, described as a methodology focusing on learners working together over a significant amount of time to develop the capacities to address often interdisciplinary complex situations and authentic problems [67] while developing critical, creative and practical skills. Pedagogically, the PBL adopted a Freirean [68] problem-posing model of education, in which through interaction, the boundaries of teacher-of-the-students and students-of-the-teachers cease to exist.

The syllabus was developed within the education for sustainable development (ESD) framework [69], enabling the young women to awaken and develop competencies within three dimensions of sustainability: environment, society and economy, with specialisation in aromatic and medicinal herbs techniques and Sicilian traditional chocolate making. The interactive curriculum originated from existing and further expansion of current theories and methods developed by networks of best practices within fair trade, sustainability education, eco-communities and agro-ecology movements. Taking into consideration that in Nigeria, 55.4% of women and girls aged 15 to 49 have completed six or fewer years of education compared to 38.3% of men and boys [70], the intention was

to provide a learning pathway for the young women and girls to develop new skills, improve their social status, and enter the ethical regional and European job market.

The learning sessions addressed the following topics:

(i) Society: enhancing solidarity between migrants and welcome communities, encouraging collaborative decision-making, developing capacities for future scenario planning, acquiring tools for conflict facilitation, sharing and supporting local traditions.
(ii) Environment: understanding the impact and developing resilience to climate change in food, land, biodiversity and water systems, bringing culture back to agri-culture, appreciation of the diversity of cultural influences on food patterns.
(iii) Economy: enhancing ethical, fair and transparent business relations, increasing autonomy from the agro-industrial system, promoting viable livelihoods and socio-entrepreneurship, bridging the gap between producers and consumers.

By engaging in the fieldwork of Mediterranean herb identification and reconnaissance, the young women deepen the sense of place and foster the process of adaptability. These activities were followed by capacity development in all stages of chocolate making—from tree to bar, including the transformation of the cacao beans into liquor, butter, powder and chocolate. The technical sessions take place at the 150-year-old family pastry shop, Antica Pasticceria Corsino, where the young migrants are introduced to traditional Sicilian chocolate-making. Rooted in the ancient Sicilian pastry tradition, Corsino claims to use the best Sicilian ingredients strictly found close at hand. Walnuts, oranges, pine nuts, lemons, mulberries and figs are all collected directly by the family Corsino in Palazzolo, with almonds from nearby Avola, pistachios from Bronte, and fruits from local vegetable gardens. With the mentoring support of the master baker, the young women refined their recipes and created their first chocolates in six different combinations.

The Herbal Youth Chocolate PBL adopted a beyond-aid social entrepreneurship approach and offered both product development and branding modules to complete the cycle of socio-enterprise development. In the business development sessions, young migrants learned how to build a basic product costing model from ingredients to production costs. They discussed the features, qualities and health benefits of chocolate as a product and explored how to develop an operational plan, taking into consideration the manufacturing process, resources, machinery and labour costs.

Through exchanges within a PBL context, they identified all types of costs needed to be included in a business plan, including raw material (herbs and cocoa per kg and gram), labour, equipment and factory-associated expenses. Finally, they calculated the break-even point for the business and price their chocolate using the collated cost data. This was followed by branding sessions introducing the importance of developing brand elements, such as logo, packaging and signage, embodying the story of the product that consumers can be emotionally attracted to. By mapping the qualities of the chocolate and their learning experience, young migrants were able to prototype the first consignment of Courage Chocolate [71].

Five hundred chocolates developed, branded, handmade and packed by the young women migrants settling in Sicily, were brought to the market for the first time at the LUSH Showcase 2018 in Manchester, UK. All four flavours of Courage Chocolate were sold-out over the two days, attracting significant interest from the engaged public eager to know where to source more. Another pilot phase was tested in Italian markets over the Valentine's period in 2019. By the Summer of 2019, the product was given a grant to develop a feasibility study and business plan for the next five years to attract the investment necessary to establish a social enterprise.

"Differences make trade" [6] (p. 79). The project is operating within a diverse territory of social tensions, which provide an opportunity for transactions across natural and social borders [6]. Pragmatically, the project combines the high biodiversity of wild herbs of the Hyblaean territory with the traditional art of chocolate making of Modica to create opportunities for the young women to specialise in organic herbal chocolate making to be sold in European fair-trade markets. In a bisociation

experiment [47] at the edges of Sicilian society entrenched in high levels of economic and political uncertainty, bureaucratic hurdles and emerging xenophobia, the prospect of innovation emerges through new socio-enterprises seeking ethical consumers and markets.

To counteract the rise of xenophobia and discrimination in the world, in 2016, the United Nations launched a campaign called 'Together—Respect, Safety and Dignity for All', highlighting the positive contributions made by migrants to economic and social development in their host countries [72]. The sociotone case presented is advancing this agenda and demonstrating that immigration could also represent a transformational opportunity and an effective way to ease people out of situations of vulnerability [73] and build long-term resilience for both the migrant and the destination communities [74].

4. Discussion and Conclusions

Empirically, the paper presented a case study upon which the concept of sociotone was tested. The concept of ecotone invites us to revisit the word 'marginal', repositioning elements that apparently contribute peripherally to a larger system into the fertile edges between systems [16]. Through enriching alliances and confrontations, the Sicilian case is maximising edges between different sociotonal communities. As bridges are built and permeable edges extended, the socio-economic choices increase. Through a nested-system approach, young female migrants are piloting the range of 'Courage' herbal chocolate produced to Italian and UK markets, while opening a range of economic opportunities to themselves and to Hyblaean herbal growers, moving systems up to higher orders of expression [33] and meaning [34].

As with all theoretical models, the proposed sociotone concept is not without its limitations. The sociotone theory may remain an intellectual abstraction if not grounded in the empirical reality, allowing its guiding principles to be tested. The findings of the Sicily study suggest that the sociotone intervention utilising sustainable community design and regenerative agriculture methods is enhancing solidarity between newcomers and local communities, encouraging collaborative decision-making and recognising the immense power for social change that lies in building multicultural communities. However, with one reported case, caution must be applied in the extrapolation of the concept to other contexts.

Ecotones and sociotones can be seen as complementary concepts with shared characteristics, but also significant differences. While there is an accumulated body of science dated from the early 20th century regarding ecotones, sociotone is a new concept emerging as a response to the multiculturalism of an increasingly globalized society.

It has been said that "all models are wrong, but some are useful" [75] (p. 74). Sociotone theory emerges in a dialogue with the natural world to suggest new pathways for the enquiry on how to negotiate and extend the permeable membranes of everyday multiculturalism in islands, cities, neighbourhoods, learning and workplaces [38]. It proposes a framework for investigating how to realise the highest systemic potential [18] of multicultural societies.

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