From the Municipal Ecological Structures to the Green Infrastructures

Views, discourses and municipal practice

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Abstract

This paper presents an evaluation of the current status of integration of the Municipal Ecological Structures (MES) in Municipal Master Plans (MMP) in Portugal, based in the confront of experts' views, with its practical application in the already approved MMP. The results show a plurality of views on this concept and that the most of municipal integration strategies is still far away from acknowledging the purposes as stated by the experts. Ultimately, recommendations are put forward on what are the main shortcomings and challenges in promoting more efficient MES at local level, following the Green Infrastructures approach.

1. Introduction

The evolution of green spaces approaches in spatial planning

Land use change is one of the most important direct drivers for the global continuous loss of biodiversity, and degradation of ecosystems and their service (MA, 2005). In Europe, since the Industrial Revolution and particularly since 1950s that urbanization has proliferated at an increasing rate (Magalhães, 1994), together with transportation infrastructures (EEA, 2006), tourism developments and intensive agriculture (EEA, 2010). The integration of open green spaces in the spatial planning approaches started in the cities, as they grew with little living conditions (lack of green spaces, noise, air pollution and traffic).

Since the concern of connect urban green areas as Olmsted proposed with the *Parkway* concept (Little, 1995; Benedict & McMahon, 2006; Waldheim, 2006), during decades different approaches have integrated urban green areas in spatial planning focused mainly on the recreational value for the population (Benevolo, 2001; EEA, 2006). However, the concerns and approaches have evolved until the integrated vision of Green Infrastructures. From the acknowledgement of its environmental and aesthetical qualities by Le Corbusier approaches (G. & S. Jellicoe, 1989; Benevolo, 2001), to the application of *Greenbelts* as a natural barrier to the urban expansion (Mumford, 1965; Ward, 1992), and integration in the strategies for mobility facilities (Caspersen, Konijnendijk, & Olafsson, 2006; Knowles, 2012).

The integration of rural areas in land use planning approaches became more lately focused, and the initial concerns were to protect huge natural areas with high value for biodiversity, creating national, regional and natural reserves. Thinking also about the needs of creating green corridors, *Ecological Networks* arose in Europe, essentially to improve the species mobility and fight fragmentation (Wheeler, 2004; Hellmund & Smith, 2006; Harnik, Ryan, Houck, Lusk, & Solecki, 2006). On the other hand, in the EUA G*reenways* were putted in practise focused in bring the population to the nature, improving its recreative and sportive benefits (Benedict & McMahon, 2006; Leibenath, 2011).

However, these efforts have not been successful to fight the land use change based in the soil consumption. As result, nearly 30 % of the EU territory is moderately to very highly fragmented (EC, 2011), while biodiversity's economic value is still not reflected in the European decision makings (EC, 2011; EEA, 2011).

The role of Green Infrastructures in the spatial planning

Green Infrastructures (GI) differ from the traditional conservation approaches, as an "interconnected green space network (including natural areas and features, public and private conservation lands, working lands with conservations values, and other protected open spaces) that is planned and managed for its natural resource values and for the associated benefits it confers to human populations" (Benedict & McMahon, 2006). Conceptually this network can be configured as Figure 1 shows, by:

Hubs – the "key habitats" to preserve or restore. They sustain the native animal and vegetal communities, where important ecological processes occur.
Links – the connections that tie the hubs. They function as corridors that permit the species mobility and genetic divide, fighting habitat's fragmentation and isolation.
Stepping Stones – small areas strategically positioned, that complete eventual continuity lacks in the links. They constitute a valid support for species mobility, too, providing refugee and nutrients.

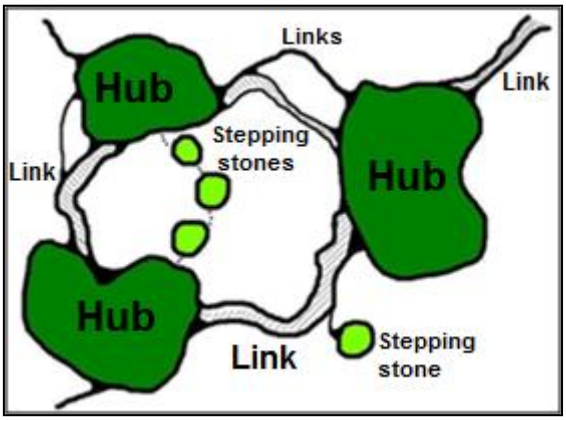

Figure 1 – Conceptual scheme for GI with *hubs*, *links* and *stepping stones*.

The system elements can differ in size, shape and function, depending on the landscape contexts, being adaptable to multiple scales. Independently on the scale, the process is supported by three main principles: (i) spatial connectivity of the open green spaces, (ii) multifunctionality of the included spaces, and (iii) collaborative public participation, involving several stakeholders (e.g. private landowners, governors, conservation and recreational organizations and local citizens) (Benedict & McMahon). *Green Infrastructures* differ from the E*cological Networks,* mainly because they adopt a large and utilitarian view of the multiple functions of the open green spaces as a whole, according to the ecosystem services and assess the various benefits that each area provides, not only the ecological proposals. It allows the identification of priorities of soils to protect and restore, and the most adequate uses and management that fits each parcel, according to its potentialities and capacities, in an integrated territorial view. Thus, this tool guides decision-making, at the same time that facilitates the communication between developers and conservationists, in preference (according to Benedict & McMahon) before the development happens, creating long-term sustainable management strategies.

The relevance of Green Infrastructures in Portugal

In 2011 the EU *Biodiversity Strategy to 2020* recognized the potentialities of GI in spatial planning, evoking them to restore at least 15% of the degraded ecosystems and reinforce its services to the population. A foreseen *Green Infrastructure Strategy* by 2012, which the member states should be called to answer, intends to promote its deployment in urban and rural areas, including the incentives to encourage up-front investments in GI projects and the maintenance of ecosystem services (EC, 2011; IEEP, 2011).

Portugal has an high diversity of ecosystems with high biodiversity and endemism, but is one of the most vulnerable European countries to the loss of biodiversity (Pereira, Domingos, & Vicente, 2004), being the land use changes and fire regime the most important direct drivers for the ecosystems change (MA, 2005). Other important drivers include the lacks in environmental legislation and the

increasing tourism, particularly in the coastal areas of Algarve, Lisbon and more recently in Alentejo (Pereira, Domingos, & Vicente, 2004; EEA, 2006).

Since 1999 Portuguese law foresees the integration of *Ecological Networks* in spatial plans. At regional scale establishes the Regional Ecological Structure, but is at local level that the implementation of the Municipal Ecological Structure (MES) by the municipalities is more sensitive, as Municipal Master Plans (MMP) have an increased regulatory power on land use changes. Municipalities are totally responsible for the MES delimitation and regulation, in continuity with rural and urban areas, adjoining the fundamental systems for the environmental protection. However, the technical concept and reference to the areas to integrate was just defined in May of 2009, and only a few MMP have being revised during the last decade, so there is still little experience on how to integrate the MES.

As the MES is the Portuguese territorial tool that fits better the GI, it is the main objective of this paper to gain a better understanding of how is the current status of integration of the MES in the MMP and its contribution to the ecological equilibrium of the Portuguese territory. It is also a purpose to explore new ways towards a multifunctional implementation and management, according to the proposed GI concept, for an effective Portuguese response to the EU *GI Strategy*.

2. Methodology

The methodology of this study is shown in Figure 2, divided in four main phases. Firstly, a review of the current literature on the evolution of the urban spatial growth after the Industrial Revolution, the multiple impacts associated, and the evolution of the spatial planning responses until the current concepts of GI and MES, at international and national scale. It was also analysed the legal framework that involves the MES in Portugal.

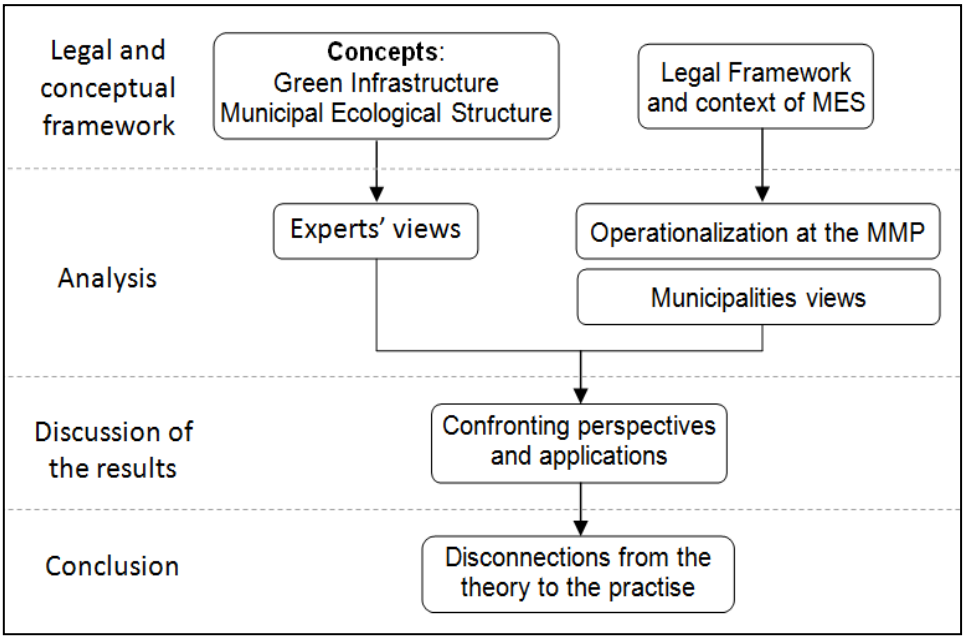

Figure 2 – Methodology outline.

At the second level, the MES Regulations in the 39 MMP already approved with this tool were thoroughly analysed, comparing them regarding its goals, delimitation criteria, land use orientations, restrictions and programming. Questionnaires were applied to these municipalities, regarding the perspectives on its natural areas and EEM. In parallel, fifteen experts were interviewed (in the fields of spatial planning, landscape quality, ecology and nature conservation, forests, agriculture, tourism and recreation, hydrogeology, energy, transports and mobility), concerning the goals, spaces to include, potentialities, contribution as a spatial planning tool and investigation needs for the MES.

The findings of this paper are based on confront its experts' and municipalities' views, as a third phase, as well as effective implementation in the MMP. This confront gives space to a critical analysis

on the accomplishment of this tool in Portugal and guidelines towards its multifunctional implementation and management, in accordance to the proposed GI concept.

3. Results

3.1. The experts' views

The results show a plurality of views about MES. The most evidenced was the ecological one – to maintain the natural continuity between important areas, and to preserve and protect the natural resources and biodiversity. Some focuses these goals in the rural areas, highlighting the importance in integrate Natura 2000 Network sites, forest and agricultural areas. Others focuses the MES in the cities, with the concern of creating less artificial cities and linking population to nature. Thus, the MES can respond to the insurance of the ecosystem services in the cities, notably by promoting recreation, leisure and sports, but also to the regulation of the biophysical processes, as well as for the aesthetical functions. Watercourses and its surrounding areas are often mentioned as spaces to include in the MES, and less the aquifers recharge zones.

Experts mention as main advantages, the multifunctionality of the included spaces, the creation of natural connectivity and strategic vision of this tool (see Figure 3). It can articulate the planning scales, realizing the regional guidance of the Regional Ecological Structure (ERPVA) (with corridors and fundamental areas) for the local scale, and create a multi-scale network of GI (from the detailed to the transnational scale). By integrating not only areas for nature protection, but also with other uses, as the recreation and leisure, MES can take advantage of the pre-existent national regimes of Ecological National Reserve (REN) and Agricultural National Reserve (RAN), often underused by the municipalities, creating "intelligent" approaches with local goals (e.g. nature tourism), since they don't compromise its national functions. By this way, according to its local goals and particular circumstances faced, municipalities can match different land uses and management for an integrated joint areas (not necessarily including legal regimes).

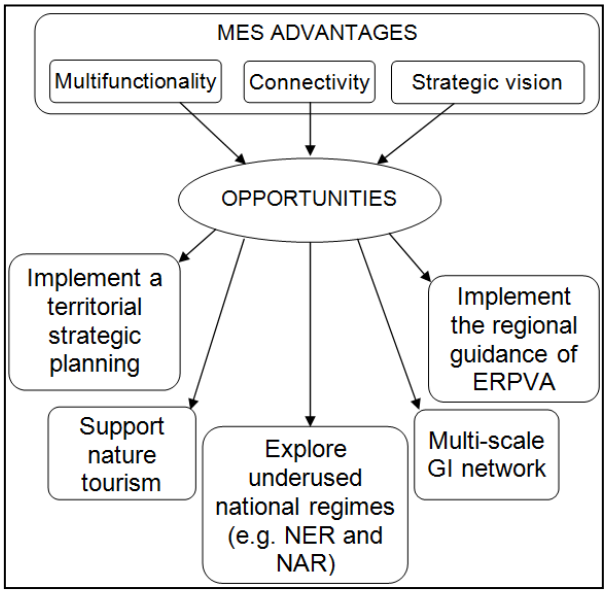

Figure 3 – Advantages and opportunities for the MES as stated by experts.

On the other hand, a wide range of barriers that difficult the success of MES are pointed out. It starts with the lack of explicitness in the legislation – the concept itself, insufficient delimitation criteria and absence of guidance for Regulation. But the "key-problem", according to the experts, is the lack of technical capacity of the municipalities to apply the scientific knowledge that underlies the delimitation, as well as a restrictive view for the biophysical processes beyond administrative boundaries. It compromises the supra local continuity of the identified spaces, in which the local administration doesn't have enough financial resources to invest in the technical capacities.

Other barriers are pointed out. The fact that most of MES studies are realized by external teams, without involvement of the municipal technical staff and decision makers, resulting in unadjusted proposals to the landscape reality. The limited knowledge or availability in scientific fields difficult the assessment of the physical and ecological sensibility of the soils (e.g. surface/ground water interface; phytosociology; pedology; soil occupation map partially available to the public). Additionally, most of rural areas belong to private landowners, but the mechanisms to use social or economical benefits from the open green spaces are not well-defined, as well as eventual compensatory measures. Thus, owners do not see benefits to collaborate in the management of the spaces. This becomes central as the national and municipal government do not have enough financial resources to purchase these areas.

A wide range of opinions also exists on the way MES and REN should relate. On this matter, standpoints that these two documents have different national and local scopes, so should not be "mixed up", contrasts with the thinking that the MES goals not only cover, but also surpass the ones of REN, thus justifying its possible substitution. In fact, is also mentioned the practical difficulties and confusion of a wide number of legal documents and regimes covering protected areas, often sharing common goals, and need to clarify the way they should relate.

3.2. The municipalities views and implementation in the Municipal Master Plans

From the 15 municipalities that answered the questionnaires, most of them showed a multifunctional view on its natural spaces. The ecological function is taken as the most important, also in accordance to the 39 Regulations of the MMP assessed, as Table 1 shows; followed by the economical one, mainly due to the agriculture activity and natural tourism potentiality in more rural municipalities. Recreation activities, landscape quality and mobility functions were mentioned mostly in the more urbanized municipalities. The most recognize MES as a spatial planning tool that informs and guides all the following spatial planning to guarantee a rational and sustainable territory occupation.

Table 1 - Attributed goals for the MES according to the Regulations of the MMP in the 39 municipalities**.**

For all the MES	
To enhance, conserve and restore biodiversity	35
To increase spatial connectivity between natural and semi-natural areas	16
To reduce the vulnerability to natural disaster risks (namely floods, droughts, water quality, coast and soil erosion)	11
Physical, visual and sound protection against roads and railways	6
To improve quality of life	4
To promote agriculture and forestry	3
Only for the urban MES	
To provide open spaces for recreation opportunities	20
To contribute to landscape aesthetics	18
To improve environmental quality	9
To set adequate measures for the conservation and valorisation of the green urban elements	3
To structure and separate the different land uses	2
To promote bioclimatic comfort	2

Geographical mapping criteria

32 of 39 municipalities identified the rural spaces of MES in the Regulation of the MMP, in which 24 also identified through a MES map. Assessing the used criteria, 5 seems to include greenways to establish an ecological network continuity (into the administrative limits). But most of the municipalities adjoined the areas under the legal regimes of Natura 2000 Network, REN, RAN and Public Water Domain (DPH), as mentioned in the Spatial Planning National Law (RJIGT), that defines the Territorial Management Instruments. The remaining ones included most of the rural soil categories (e.g. forest, agricultural and natural areas), covering the most part of the rural territory.

Despite most of municipalities state to include also forested areas, only few cases explicit having of the integration of Regional Forest Plans, notably with forest corridors, or ERPVA (e.g. with anchor areas, primary and secondary corridors), as well as other territorial plans (e.g. river basin plans or costal plans).

The concerns on water resources varies, between the total integration of rivers, lakes, flood zones, riparian buffer strips and ground water, and no concern at all. By confronting MES maps of neighbouring municipalities, these variations in criteria delimitation showed discontinuity.

Regarding the identification of the urban MES, most included public green spaces (e.g. gardens and parks), but also privately owned (e.g. farms and gardens), areas with high ecological value, relevant set of trees and other permeable green spaces. More urbanized municipalities detailed more the used criteria to determine these spaces.

Regulation of MES in the MMP

Only 12 municipalities establish a Regulation for the rural area of MES (see Table 2), in which half of those referred some guidelines for human activities to not compromise the preservation on natural resources and the continuity of ecological processes. The other half add restrictions for land use and actions, such as topography changes, construction for habitation, vegetation destruction (except for agriculture and forest activities), waste deposition and intensive agriculture. The other 30 refers that rural MES is regulated as the Rural Soil Regulation states. Actually, most refer in the questionnaires that the previous MMP (without the MES) was already efficient in the protection of the natural spaces. It was also verified that the 5 municipalities that established greenways, also stated the suitable land uses and limits for construction in urban and rural spaces.

30 municipalities regulate its urban MES, allowing the construction of equipments to support the recreation, leisure and sport activities (e.g. sportive, educational and cultural spaces, food & drinks and esplanades). 22 establish the conditions for construction, limiting the maximum constructed area *per* portion of green area, and requesting detailed plans (10) or the guarantee of green spaces continuity. Most programmes the creation of new green urban areas for recreation, associated to the expansion of urban and touristic areas. Some also programme the requalification of watercourses, mainly associated to riverfront urban regeneration programmes.

Table 2 - Urban and rural MES application levels in the 39 municipalities.

		Rural		Urban	
Do not consider it		3		-	
Stipulate goals		2		2	
Stipulate goals and delimitation	Only in Regulation	6		4	
	Also in map	15		3	
Stipulate goals, delimitation and regulation		9	1	25	3 No delimitation
			2		2 Delimitation only in the Regulation
Stipulate goals, delimitation, regulation and programming for rural and urban MES		6			

3 Discussion

Theory to practice

While the experts are more concerned with the functions and ecosystem services that MES can provide, in practice, the municipalities do not visualize this tool as a potentiality, but as a mandatory requirement and are therefore unable to take advantage of it. Actually, the mentioned ecological priority between the multiple goals of the MES, gives rise to a mainly anthropocentric implementation, focused in the creation and regulation of leisure and recreational areas in urban spaces to the population. Thus, the ecological view of the municipalities seems to be, actually, a discourse, while the other potentialities are less put in practise. In fact, while the experts highlight the creation of continuity

as a big advantage – not only spatial natural corridors, but also the continuity between scales, just a few municipalities fulfil this principle; most local practices appoint for discontinuous MES:

- The union of REN, RAN, Natura 2000 network and DPH spaces as delimitation criteria for the rural MES do not concern on the creation of natural corridors. By not integration the Regional Forest Plans, they can ignore the important role of forest perimeters as green corridors.
- The discontinuities in the MES maps suggest a partial view by the municipalities and lack of communication.
- The guarantee of continuity of urban green spaces or landscape/detailed studies in case of construction is still few required in urban MES Regulations in the MMP.

Dealing with the rural - urban dichotomy

The small group of 5 municipalities that created maps with greenways linking selected important areas to protect, and established the suitable land uses and limits for construction in urban and rural spaces, indicates that apparently this tool is being implemented promoting the natural continuity. However, this is a positive trend but most of the municipalities have difficulties in identifying suitable rural MES maps and regulate them.

On the other hand, it is easier to pass the urban MES from the concept to the practise, especially in more urban municipalities. In the cities, the parks, gardens, cycle ways and other urban green spaces that attend to the social needs are clearly being recognized by promoting recreation, leisure and sport. It seems that these social function is being placed on top of the concern of guarantee the environmental and ecological quality, as municipalities always regulate its urban MES admitting the construction for recreative, sportive, cultural, educational buildings, but not all concern about establish a maximum limit for the construction and landscape studies, and even less concern on requirement the guaranty of connectivity between green spaces. Thus, according to the historic development of urban planning approaches, it seems that many municipalities are still in the phase of concern only about recreative challenges, while the integration of ecological concerns, is less evident and only present in a smaller group.

Lacks of the Regulation of rural MES in the MMP, together with the opinion that the previous MMP was already efficient in the protection of natural areas suggest that they included these regimes under the obligation to comply the law. Once the Spatial Planning National Law mention theses regimes for the MES but do not give orientations for the Regulation and no harmonized criteria are provided.

This situation seems to confirm some barriers mentioned by the experts for the implementation regarding the lack of capacity on apply scientific knowledge in municipalities. So the law gives space for strategic approaches at local level, but many municipalities have not enough technical capacity. Furthermore, they may not be prepared in terms of strategic view, so many MES studies are being developed without the concern of integrate both knowledge – expert's and municipalities.

4 Conclusions

In line with the achievements of Green Infrastructure at European level (EC, 2012), also in Portugal this study concludes that the MES has a high potential for a more strategic spatial planning, towards more sustainable land use decisions and biodiversity protection. There is already a positive dynamization in the integration of this concept, mainly at urban scale, protecting green urban spaces, creating recreational, leisure and sports spaces to population and requalifying natural elements in the urban landscape, specially watercourses. Thus, urban MES is promoting the environmental quality and higher living conditions in the cities, specially the social benefits of these spaces. Moreover, some municipalities already implemented a MES that gives priority to the creation of natural continuity in urban and rural space, regulating it for a correct development of the human activities, according to the natural capacity of the natural systems, and programming action to requalify the natural spaces. However, the municipalities are in different application levels of this concept, and in most of cases, it is still far to be putted in practice – municipalities give priority specially to the social functions of the green urban areas, showing difficult to transport this concept to the rural areas, both in the mapping and regulating land uses.

Thus, it is needed more support to put in practice the potentialities presented by experts – multifunctionality of the included spaces, creation of natural continuity and strategic vision. As starting point, it requires: (a) the recognition of the importance of this tool for who is responsible for the implementation, in order to be fully taken in consideration; (b) a discussion regarding the spaces that must be included; (c) the development of an integrated approach for the MES, requiring not only legal Regulation, but also efforts in both governance and public participation, as well as allocation of financial resources. To improve the identified problems, this study suggests:

First of all, the current set of legal regimes and plans for soil protection difficult a practical view of spatial planning. Municipalities strongly rely on legislation, as historical planning is Portugal is normative and not strategic, so there is the need to clarify the articulation between MES with the REN and DPH in the national legislation. In case of a "dismembered" REN and its protective regime, as spread out by the media, MES has to reinforce its Regulation on legislation.

At the municipality level, also a more "participative" approach is needed, with the involvement of the several stakeholders, and starting with the municipal technicians in the delimitation of MES, forming mixed teams with the external experts, which improves the quality of the study and facilitates the adoption of a critical vision over the SIG results. In this process it is essential to adopt a more holistic and integrated view of the territory beyond administrative limits, as the biophysical processes surpass these limits, so neighbourhood municipalities must improve its communication and collaboration, together with an increased consideration of the regional guidance of the Regional Ecological Structure, Regional Forest Plans and Watershed Plans to the local level, facilitating the identification of green corridors that prioritize the natural continuity in a global view, and the response to drought and floods. At the urban MES is suggested to require Detailed Plans and Landscape Studies when constructions are admitted. A "key-point" for a more strategic implementation of the MES, is to involve several stakeholders and develop partnerships, specially with farmers and forest landowners that have its properties included in the MES, in the more rural municipalities. Thus, from the previous analysis can result a "fundamental" MES (not strategic, integrating the essential areas for the ecological equilibrium of the territory), and then discuss the development of strategies for the less environmentally sensitive soils, integrating identified potentialities, and common values shared by the stakeholders, where some areas can be integrated or withdrew. Finally, it is proposed, that a Management Plan should be mandatory, as a starting point t improve the discussion between municipalities, experts, private landowners and public in general. It can improve the operationalization of this tool, for example, by establishing goals and measures to achieve them, the role of the various stakeholders in the management of the included spaces, by identifying the priorities and the monitoring tools.

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