Establishment of a Regular Management Mechanism for Green Pest and Disease Control in Urban Street Trees

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Abstract: Pests and disease incidences in urban street trees are common, affecting the function of urban ecosystem service and landscape aesthetics. In particular, the environmental pollution problem and pesticide resistance crisis caused by chemical control methods are becoming more and more serious. Therefore, it is urgent to build a scientific system of pest disease regular management model without harming the environment. This paper analyzes the practical difficulties in current practice of urban street tree pest and disease monitoring, early warning, technology application, department collaboration and public participation. Four dimensions are proposed, systematic mechanism optimization strategies through building intelligent monitoring and early warning network, establishment of an ecological control technology system, improvement of a coordinated management and operation mechanism and social participation co-governance framework. This to replace inputs of short-habilitate is the long-term solution for urban street tree pest and disease control, and enhance the modernization of urban ecological governance capabilities.

1. Introduction

Urban street trees, as the kernel of urban green space system in city, play indispensable roles for regulating microclimate, purifying air and mitigating heat island effects. They are key to improving life in a city and its inhabitants. Pest and disease outbreaks are growing more prevalent with urbanization (rapid growth) and extreme climate events, necessarily posing a substantial challenge to the ecological security of cities. Under the guidance of ecological civilization construction and the "dual carbon" goals, the concept of green pest control has gradually become the mainstream direction for urban pest management. Replacing traditional chemical control with eco-friendly technologies such as biological and physical control, and establishing a regular management mechanism, has become an inevitable requirement for promoting sustainable urban development and an important pathway to achieving harmonious coexistence between humans and nature.

2. Value Orientation of Regular Management for Green Pest and Disease Control in Urban Street Trees

The general orientation of urban street tree green pest and disease control management is an important internal requirement for the construction of ecological civilization and high-quality urban development. Although street trees are an essential part of the urban ecosystem, their condition directly impacts urban biodiversity security and environmental quality. Fundamentally changes in control models from passive extent to active integration with a management system that is prevention focused can transform traditional methods, allowing for source control and full process pest and disease management. This management model advocates ecological balance and natural regulation, which can improve the self-repair and anti-stress ability of urban green space system by establishing habitats for natural enemies, breeding resistant varieties, and optimizing planting structures. This is to ensure that street trees offer environmental dependability in a more resilient manner. Moreover, regular management incorporates pest and disease control into urban governance systems which orientates a change in management from post-event remediation to pre-event prevention, transformation from single-department management to multi-stakeholder

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collaborative governance, and innovation-driven solutions for ecological technology rather than chemical approaches. This cultivates a new pattern of harmonious coexistence between man and nature urban development.

3. Practical Challenges in Regular Management for Green Pest and Disease Control in Urban Street Trees

3.1 Gaps in the Monitoring and Early Warning System

The poor performance of the monitoring and early warning system for urban street tree pest and disease severely limits the proactivity and precision of control efforts. Manual inspections depend on the number of staff and their subject area knowledge, which leads to low inspection frequency and coverage. Frequently, pests and diseases are only identified once damage has taken place. On the other end of it, technological means such as IoT sensors and smart image recognition take long to adopt (due to high initial investment) in combination with maintenance costs. Monitoring efforts are dominated by window areas (e.g., main roads, commercial centers, and government buildings), while street trees in secondary roads, backstreets, and old residential areas—which absorb the losses of daily life—are left in monitoring vacuums. Continuously not well looked after, or outdated woodlands have the possibility fragmented wilderness qualities and became extra susceptible to bugs and illnesses [1]. Despite the rich data collected by different functional departments, it lacks an integrated information-sharing mechanism and data standards to interconnect and analyze meteorological warnings, pest monitoring results as well as maintenance records comprehensively. As a result, the warning lagged behind and the judgments were one-sided, so that grassroots units had to depend on more experience-based rather than scientific and accurate control measures.

3.2 Uneven Application of Control Technologies

The non-uniform use of control technologies echoes the chronic inefficiency of green control conception and an immature technology transfer system. Grassroots maintenance units generally have an inertia with the mindset of chemicals first and then ecology, as chemical pesticides are fast acting, easy to apply and cheap. While they prefer biological control, they are very doubtful about it because of the longer period it takes to implement and its high cost compared to effective physical-control equipment. Even if natural enemies are widely distributed, but without regular organized technical training ever produced or practical guidance, the unit does not know how to release them effectively. Inappropriate use of plant-based pesticides can reduce efficacy even further. Maintenance funding is based on the traditional model and does not take into account green control technologies specificity. This puts ecological control methods at a short-term cost disadvantage for units that have adopted them and both direct performance evaluations of managers and indirect effects in hiring and reimbursement decisions overemphasize immediate gains from chemical control, further entrenching dependence on it. The resulting mismatch in the way that technology is applied contributes to ecological problems including pesticide residue accumulation, increased pest resistance, and reduction of natural enemy populations thereby driving up control costs so that efforts become trapped in a process of "more pesticides, worse pests, higher costs".

3.3 Lack of Coordination in Management Mechanisms

One of the essential systemic barriers that block effectiveness in pest and disease control is fragmentary and uncoordinated management mechanisms. The greening department provides technical guidance but has no enforcement power, the landscaping department manages green spaces (not street trees), the sanitation department cleans fallen leaves but does not kill insects and bugs, and street offices handle local management but lack professional expertise. The meaning of this "nine dragons ruling the water" scenario is blurred lines and bad control measures. Because there are no regular communication and coordination mechanisms, emergency teams tend to be formed only in the aftermath of a severe pest outbreak but then operate independently with poor information sharing, leading not only to duplicated efforts but also control gaps. Controlling pests

and diseases across regions is more difficult: different administrative areas perform control independently in terms of when, how and what to use as a pesticide for the most part—pests have overall opportunities to migrate or spread [2]. The present assessment system places too much emphasis on visible indicators like incidence of pests and tree mortality, while underplaying deeper errors which include innovation in control technology, ecosystem health or the ability for sustainable development. This prompts managers to use emergency or campaign style control instead of permanent mechanisms.

3.4 Low Level of Social Participation

In summary, the lack of social engagement reflects deficiencies in creating awareness and building mechanisms to encourage public participation in HSR pest and disease control. Street trees, for the most part, are seen only as city fixtures to be managed by City Hall. Such disownership and lack of awareness lead to daily practices harmful for tree health, and that favour introduction of pests: nailing objects on trunks, dumping waste water into the pits or pruning without authorisation. Community organizations, property management companies and businesses located along the street which could be vital links in a system of protection for street trees are often ambivalent often taking a watch-and-wait attitude because there is no apparent avenue to participation and their interests may not align. They hardly report or act even with discovery of pests. As a result, there is little coverage of urban ecology and pest control in environmental education in schools, leading to naive understandings among youth, yet failing to build an effective environmental conservation mindset with real depth. The professional service market is also relatively undeveloped, with limited social organizations able to provide pest monitoring, biological control and technical consulting. Their lack of numbers and scope prevents them from realistically government-transferred service functions, thus preventing the socialization and marketization of control efforts.

4. Strategies for Establishing a Regular Management Mechanism for Green Pest and Disease Control in Urban Street Trees

4.1 Building an Intelligent Monitoring and Early Warning Network

To establish an intelligent monitoring and early warning network, it is essential that modern information technology be fully applied in this area to monitor pests and diseases in a precise manner, and provide responsive warnings. Each measurement point for IoT monitoring is placed every 500 meters in the area with a high concentration of street trees (e.g., main roads, parks and residential areas). These points must be fitted with integrated sensors that measure temperature and humidity, high-definition cameras, insect monitoring lamps used to collect environmental parameters and pest activity data in Ahmedabad for 24/7. Send the data collected in real-time to the urban greening management center data platform through 5G networks. Deep learning algorithms for training pest identification models to identify pests, density, and damage levels by analyzing images automatically. Warnings are triggered automatically when monitoring data exceed preset thresholds. Split the city into grid units of 1 km2, each using 2–3 dedicated inspectors with mobile terminals that include GPS and photo functions to patrol designated routes daily. Abnormalities are to be photographed, uploaded and geo tagged in real time [3]. Develop a multi-dimensional data fusion analysis model by integrating (data from) meteorological departments (temperature, humidity, rainfall), landscaping departments (tree species, age and maintenance records) and sanitation departments (garbage collection frequency). The model should be able to predict the probability of occurrence and spread trends of pests & diseases, seven to fifteen days ahead.

4.2 Establishing an Ecological Control Technology System

To build an ecological control technology system, it is better to systematically promote source control and process intervention, to make technical measures science-based and operation feasible. Wherever possible (especially along new roads and tree renewal), over 70% of plantings for new road greening projects should consist of locally adapted pest-resistant tree species including ginkgo,

pagoda tree, and goldenrain tree. Grow insect-repelling plants like mint and rosemary around the tree pits, while planting clover and liriope underneath of street trees to serve living space for natural enemies. Identify overwintering sites for beneficial insects such as ladybeats and lacewings, by installing insect hotels every 100 meters. Set up breeding bases of natural enemy insects with an annual output of 50 million Chouioia cunea and 1 million Harmonia axyridis. Natural enemies should be released during the 15 days before the peak of pest periods, and the number of each natural enemy was calculated separately according to pest density per tree, and generally up to 3–5 times. Promote plant-derived pesticides, e.g., 0.3% neem oil emulsion （concentration-controlled at 0.1%–0.3% and applied no more than three times per year）and 1.2% nicotine·matrine (where the calculation of alkaloids is used in doses). Deploy solar insect traps in vulnerable regions (schools / hospitals / residential neighborhoods). Each trap has a working radius of 30 m. In a physical control harbours over 60% capture, using in combination with yellow sticky boards and pheromone traps.

4.3 Improving Coordinated Management and Operation Mechanisms

The essence of improving the coordinated management and operation mechanism is to clarify the boundary of responsibility and establish a highly efficient coordination and linkage mechanism to ensure that control measures can be maintained systematically, continuously and normalized. Release "Urban Street Tree Pest Control Management Measures", fully define municipal greening departments in annual control plans, technical standards and funds; district landscaping department responsible for implementation, technical guidance; street offices to do a good job in daily inspection and information reporting; Maintenance enterprises can execute specific tasks as approved by the contract. Establishing the municipal, district, street and enterprise four-tier linkage system. Conduct monthly pest control kick-off meetings to be held within 72 hours of large outbreaks of major pests plagues. Create Wechat work groups to communicate and coordinate in real-time. Uphold Cross-Region Prevention and Control for Pests At the same time, green control technology use method (30%), reduction rate of chemical pesticide application (25%), public satisfaction (20%) and emergency response timeliness (25) should also be included in comprehensive urban management skiless evaluation for pilot projects. Unit maintenance funding should be benchmarked against evaluation outcomes with non-compliant units losing their qualification after two years.

4.4 Fostering a Social Participation and Co-Governance Framework

To establish a social participation and co-governance framework, it is necessary to not only improve the comprehensive use of various participation channels but also help establish incentive mechanisms that can enable active participation by all non-governmental actors in the process. Create a "Urban Tree Health" mobile app, with which citizens can report malady by attaching images. Automatically geo-locate and alert countermeasures nearby maintenance units, feedback on treatment results within 24 hours. Pick 10 excellent reporters a month and give them 200 yuan. Establish street tree maintenance channels in communities by making community bulletin boards with pest control knowledge (updated quarterly). Prepare an ecological education based on the "Little Tree Guardians" practical activities aimed to primary and secondary school students for four class hours of this kind of activity per semester [4]. Launch a corporate sponsorship and adoption program with a three-year term, placing identification plates on adopted trees. Adopting enterprises should receive corresponding carbon sink certificates and tax benefits. Support the development of 10 professional pest control service companies, with the government purchasing services such as natural enemy breeding and supply, pest monitoring and assessment, and emergency control. Service fees should be paid at 80% of market rates. Establish a volunteer points system, awarding 2 points for one hour of patrol participation, 5 points for and 3 points for providing valid information. Points can be exchanged for rewards such as annual park passes and parking coupons. The top 100 volunteers annually should be awarded the "Green Guardian" honorary title.

5. Conclusion

The establishment of a regular management mechanism for green pest and disease control in urban street trees is a systematic project requiring coordinated efforts in technological innovation, institutional improvement, and social mobilization. By building an intelligent monitoring and early warning network, an ecological control technology system, a coordinated management and operation mechanism, and a social participation and co-governance framework, thescientific nature, precision, and sustainability of pest and disease control can be effectively enhanced. This is not only a practical need for maintaining urban ecological security but also an important manifestation of advancing the modernization of urban governance systems and capabilities. It holds significant meaning for building beautiful, ecologically livable cities.

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