Proceedings of the Seventh International Conference on Urban Pests
William H Robinson and Ana Eugênia de Carvalho Campos (editors) 2011
Printed by Instituto Biológico, São Paulo, SP. Brazil.

A RETROSPECTIVE ANALYSIS OF STRUCTURES INFESTED BY SUBTERRANEAN TERMITES IN PHILIPPINES

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Abstract This is a retrospective analysis on 502 individual structures to determine if there exists any specific reason for a structure to become susceptible to termite attack. Individual parameters were collected from each of the structures for performing the analysis. The parameters selected were location of the structure (urban, or suburban); construction method (constructed by a developer or individually constructed); age (over or below 5 years), landscape (presence or absence); area (with or without surrounding unused land); economic level of the owner (upper or middle class). The parameters were subjected to a chi square test to provide possible conclusion. The results show that termite infestation is significantly associated with structures with landscape, constructed by a developer and owned by middle class. Further, in structures owned by middle class, construction method is a dominant determinant to infestation than presence of landscape. In contrast, among the upper class owned structures, landscape is a dominant risk factor than construction method. The results are further discussed in this article.
Key Words Landscape, construction methods, urban, suburban

INTRODUCTION

A recent survey by the author has conservatively estimated 30% of structures in city of Manila to be either with active termites or had records of previous infestation. Termite damages to structures in Philippines are extensive due to poor orientation of builders towards termite control practices, absence of building codes specific for termites and indifference of owners on safe practices. Consequent to this, most structures get easily infested needing repeated treatments.

In Philippines, structures and buildings are designed and constructed with steel and concrete to resist both typhoons and earthquakes. Houses are constructed using slab on the ground flooring. All commercial construction makes use of a monolithic slab while houses often lay slabs which are laid in parts. Termites gain entry to the structure through cracks, joints, utility openings in the sub floor and sometimes by forming over-ground mud tubes. Wood is extensively used, most often unscientifically without considering termites as a major problem. Wood flooring, wooden baseboards, false walls, wall decorations, ceilings, staircases, doors and windows are common features of a structure. These are also the site where infestations start.

Philippines present a rich termite fauna, of which four subterranean species are the primary reason for causing major structural damages. This article performs a retrospective analysis on over 500 individual structures infested with termites to determine if there exists any specific reason for a structure to become susceptible to termite attack. The article discusses the results obtained in this analysis.

MATERIALS AND METHODS

A single pest control operator took part in this work over a period of 4 years between 2005 and 2009. Data were collected from clients when either call was made to the office of the pest controller or on subsequent visitation to the building for a survey. The data on following parameters were meticulously collected:

1. Location of the structure: Urban, or Suburban.
2. Age of the Structure: Above or Below 5 years.
3. Landscape: presence or absence. (Presence, indicate a garden on at least two sides of the structure).
4. Area: with or without surrounding unused land. (E.g. A club house in center of a golf course is noted as area unused, whereas a detached house in a gated subdivision is noted as area used)

5. Socio economic level of the owner: upper or middle class.
6. Construction method: constructed by a developer (Developer) or individually constructed using a contractor (Self). (E.g. Developers indicate a single company which develop the land, build and sell houses to consumers).

Only trained technicians were used for the entire survey work to keep the interpretation and data collection uniform. Information on subfloor construction patterns and preconstruction termite protection details could not be collected from most structures. This information was not used for drawing any conclusion in this analysis. Data were also collected from 52 un-infested structures, which served as a control group for the analysis. The parameters used were same as that of infested structures. These structures were selectively chosen and structures with previous record of infestation were not included in this group. *Chi square* analysis was used to do the analysis.

RESULTS

A total of 450 structures infested and 52 un-infested structures formed part of this retrospective analysis. The structures represented the entire country, representing 28 cities and towns. The maximum distance between two structures was approximately 1200 km North-South and 500 km East-West. The altitude ranged from mean sea level to 1500 meters above the sea level.

Parameters Associated with Infestation

The analysis using chi-square test show that termite infestation appear to be significantly associated to structures with landscape (p value =0.0004). Also structures owned by middle class (p values = 0.0045) and constructed by a developer (p value= 0.015) showed higher termite infestation (Table1). There was no statistical difference in termite infestation between structures located in urban or suburban areas, having used or unused areas around the structures and age of the structure as less or more than five years (Table 1).

Table1. Distribution of 450 infested and 52 un-infested structures according to the individual parameters.

Parameters	Infested (n=450)	Un-infested (n=52)	p value
Location			
Urban	293	31	043
Suburban	157	21	
Landscape			
Present	324	28	0.004
Absent	126	24	
Area			
Used	378	44	0.904
Unused	72	8	
Socio-Economic status			
Upper	153	28	0.0045
Middle	297	24	
Construction			
Developer	346	32	0.015
Self	104	20	
Age of the house			
More than 5 years	363	44	0.49
Less than 5 years	87	8	

Significance of Socio-economic Status and Construction Method on Infestation

Further analysis show that structures constructed by developers are associated with higher infestation than self-constructed structures, irrespective of the socioeconomic status. Also, for a similar type of construction, middle class owners have higher infestation than the upper class (Table 2).

Table 2. Analysis of infestation in relation to socio-economic status and construction method.

Parameters	Infested (n=450)	Un-infested (n=52)	p value
Upper Class			
Developer	141	20	0.0013
Self	12	8	
Middle Class			
Developer	205	10	0.0061
Self	92	14	

Significance of Landscape on Infestation

Presence of landscape is significantly associated with infestation (Table 1). In addition, Table 3 shows that landscape is significantly associated with structures constructed by developer. It could mean that presence of landscape could be a reason for the high rate of infestation in developer made structures. However, it remains inconclusive whether landscaping and type of construction are independent risk factors or one is dependent on the other.

Table 3. The distribution of landscaping with respect to type of construction.

Parameters	Developer	Self	p value
Landscape present	282	67	<0.0001
Landscape absent	96	57	

To further test the relationship between landscape, construction method and socio-economic class an analysis is undertaken as depicted in Table4 and 5. In middle class, for both types of construction, landscape does not contribute to infestation. However in upper class landscape significantly increases the risk of infestation (Table 4).

Further for both socio-economic groups, structures with landscape, infestation is same irrespective of the type of construction (Table 5). In addition in those structures without landscaping, construction done by developer has significantly higher infestation than self construction. The difference is much marked ($p < 0.0001$) for upper class than middle class.

Table 4. Analysis on significance of landscape on construction method in both socioeconomic groups.

	Landscape present		Landscape absent		p value
	Infested	Un-infested	Infested	Un- infested	
Middle Class					
Developer	148	7	57	3	0.885
Self	61	7	31	7	0.231
Upper Class					
Developer	104	10	37	12	0.0069
Self	11	1	1	5	0.0014

Table 5. Analysis on significance of construction method on landscape in both socio-economic groups.

	Developer constructed		Self-constructed		p value
	Infested	Un- infested	Infested	Un- infested	
Middle Class					
Landscape present	148	7	61	7	0.106
Landscape absent	57	3	31	7	0.034
Upper Class					
Landscape present	104	10	11	1	0.952
Landscape absent	37	12	1	5	<0.0001

Relative Risk Analysis Among the Three Significant Parameters

A relative risk analysis among all the three parameters which are noted to be significantly associated with infestation is shown in Table 6 and 7. In middle class owned structures, the maximum range of risk is 4.8 times between minimum risk structures (self-constructed without landscape) and the highest risk structures (constructed by developer with landscape). However the risk value is 2.0 between self-constructed without landscape and self-constructed with landscape. This indicates that for a middle class structure, construction by developer add more risk than landscape (Table 6).

Table 6. Relative risk analysis among middle class structures with landscape and construction method as two determinant parameters for infestation.

Group 1 structures	Group 2 structures	Relative Risk*
Constructed by developer with Landscape	Constructed by developer without Landscape	1.2
Constructed by developer with Landscape	Self-constructed with Landscape	2.4
Constructed by developer with Landscape	Self-constructed without Landscape	4.8
Constructed by developer without Landscape	Self-constructed with Landscape	0.9
Constructed by developer without Landscape	Self-constructed without Landscape	4.0
Self-constructed with Landscape	Self-constructed without Landscape	2.0

*Relative risk ratio is calculated as odd ratio. A value of 1 indicates that both groups are at similar risk.

In upper class, the range of relative risk between the minimum risk structures (self-constructed without landscape) and the structures at highest risk (constructed by developer with landscape) is 52. However the values is reduced to 15.4 by changing the construction method (constructed by developer without landscape), but increases to 55 with addition of landscape (self-constructed with Landscape). This indicates that landscape has a bigger influence on infestation than construction method in upper class structures (Table 7).

Table 7. Relative risk analysis among upper class structures with landscape and construction method as two determinant parameters for infestation.

Group 1 structures	Group 2 structures	Relative Risk*
Constructed by Developer with Landscape	Constructed by Developer without Landscape	3.4
Constructed by Developer with landscape	Self-constructed with landscape	0.95
Constructed by Developer with landscape	Self-constructed without Landscape	52
Self-constructed with Landscape	Constructed by Developer without Landscape	3.6
Constructed by Developer without landscape	Self-constructed without Landscape	15.4
Self-constructed with Landscape	Self-constructed without Landscape	55

*Relative risk ratio calculated as odd ratio. A value of 1 indicates that both groups are at similar risk.

DISCUSSION

Prevalence of termites in a region makes all structures in the area prone for infestation. It is thus essential that some type of intervention method is used to prevent their entry in structures and cause damage. However in practice, very few structures are built with termite protection in its design. To overcome this, many countries have intervened and enforced building code as mandatory. Adherence to such federal regulation has considerably improved structural protection. But most methods of intervention are challenged by nature and human activities which continue to make structures susceptible to termites in its lifetime.

It often intrigues termite managers what could possibly make a structure favorable to infestation in a termite prone area. Researchers have shown that a host of intrinsic factors govern termite foraging which could determine final food selection. Predominant among them could be those which increase the overall fitness of the colony such as distance from the nest, nutritional quality (Lenz, 1994) and also intra-specific and inter-specific territorial interactions (Holldobler and Wilson, 1990). It is also evident that termites use specific search methods to locate food and may use cues as carbon dioxide (Bernklau, 2005) and fungal emanation (Su, 2005).

This study is aimed to look for a pattern among a number of parameters which could determine a structure venerable to termite infestation. The retrospective analysis showed that structures associated with landscape, owned by middle class and constructed by developers have significantly more infestation (Table 1). Landscape and gardens around structures could serve as a source for moisture and food attracting termites in the area, indirectly making the structure prone for attack. Interestingly structures constructed by developers showed significantly higher infestation than self made structures (Table 2). This could be because developers often use unutilized lands with natural undergrowth or agricultural land for building these structures. These areas are usually colonized by termites and eventually would be a reason for easy source of infestation. Most of these structures are part of urban sprawl where population had been relocating.

It is interesting to note that when all the three parameters key to infestation namely socio-economic, construction and landscape is analyzed together, the significance of each parameter is evident. In middle class structures, construction method is a dominant determinant to infestation than presence landscape. In contrast among upper class structures, landscape is a dominant risk factor than construction method (Tables 6 and 7). Further the observation helps to concluded that when two risk factors are present, addition of a third risk factor does not alter risk much. But in absence of risk, a single factor substantially increases risk of infestation.

In spite of limitations of having smaller control group for comparison, the study reveals the combined effect of key parameters in determining infestation. Presuming middle class structures with limitation in using superior quality materials and fool proof design, construction method becomes a dominant factor compared to landscape in determining termite infestation. While in upper class structures which has access to quality products and services, landscape becomes the determinant factor for infestation.

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