Managing Subsidence

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Abstract: The issue of subsidence is important in many parts of the country. Whether caused by mines collapsing, oil pumping, or weather, property owners are faced with how to finance these losses, which are not typically covered in standard property policies. Several states have devised funding mechanisms such as reinsurance facilities and organizations specifically designed to provide subsidence insurance in an effort to offer property owners some protection against certain types of subsidence losses. This paper explores the various causes of subsidence and discusses some of the solutions states are currently employing. The paper also investigates the appropriateness of extending the funding mechanisms for mine subsidence to other subsidence-related perils such as sinkholes. [Key words: subsidence, sinkholes, reinsurance, risk-financing]

INTRODUCTION

As defined by the National Oceanic and Atmospheric Administration, subsidence is "the lowering of a portion of the earth's crust, which causes a loss of surface elevation due to the removal of subsurface support" (National Oceanic and Atmospheric Association, 2003). Subsidence can be caused by natural conditions, such as sinkholes, or human activity, such as groundwater removal. Regardless of the cause, major subsidence losses have cost homeowners, businesses, and governmental entities billions of dollars over the years. While perils related to earth movement are traditionally excluded from most property policies, several states have man-

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dated coverage for certain subsidence-related claims. However, there are limitations on what qualifies for coverage and the amount of coverage that can be obtained. Uninsurable properties, as well as losses that exceed the maximum coverage available, can lead to financial distress for homeowners and businesses alike. In addition, losses to government-owned land and infrastructures have resulted in costly repairs in several states. In California, for example, subsidence resulting from water pumping and oil and gas mining caused a 20-square-mile area of land to sink nearly 30 feet. Damages and remediation costs reached an estimated $100 million (City of Long Beach Department of Oil Properties, 2000). In Ohio, the collapse of a mine under I-70 resulted in estimated damages of nearly $4 million and caused the highway to close for several months (Crowell, 2001).

Because of their severity, subsidence losses have become a major concern in several states. The issue is twofold: (1) should subsidence be a mandatory coverage in standard property policies and (2) if coverage is provided, how should losses be funded? Several states now require insurers to offer coverage for subsidence, while others have mandated coverage in standard policies. Some states use a combination approach, making coverage mandatory in counties most likely to be affected and optional in other counties. In addition, various states have established funding mechanisms, such as reinsurance facilities, to fund these losses. Others, including Florida, have no specific funding mechanism but have made coverage of certain types of subsidence mandatory in the standard property policy. In states where no coverage is available for subsidence, property owners must independently determine how to finance potential losses.

Over the years, several states, including Illinois, California, Texas, and Florida, have commissioned studies to examine the extent of the problem in an effort to determine the best means for dealing with the issue of subsidence. For example, in 1992, the Florida Legislature, in response to increasing complaints about the frequency and severity of sinkhole losses, commissioned a study. The study was conducted by the Florida State University Center for Insurance Research under the direction of the Florida Department of Insurance. The Legislature mandated that the study examine and evaluate the potential insurance rate impact of damage resulting from the formation of sinkholes in the state upon homeowners insurance coverage both statewide and within geographical territories in the state. The study also examined and evaluated alternatives for insuring the risk of damage caused by sinkhole activity.

The report demonstrated that the frequency and severity of sinkhole claims had increased dramatically, rising from 35 reported claims in 1987 to 426 in 1991 (Butler et al., 1992). Because of more pressing problems, such as the impact of Hurricane Andrew, developing a funding mechanism for

sinkholes was not a priority for insurers and regulators in the state at that time. As shown by the results of a more recent survey conducted as part of this study, sinkhole claims in Florida are again rising, and developing a means of funding these losses has again become an issue of interest.

In addition to establishing regulations related to insurance coverage and/or the appropriate funding mechanism, states also must deal with the problem of determining the nature of the subsidence. It is often difficult to determine if the subsidence is the direct result of a covered loss or if it is caused by perils typically not covered, such as the decay of organic debris or a construction defect. In situations where only a specific type of subsidence is covered, a correct determination is critical. This problem can result in disputes between insurance companies and property owners as well as developers and property owners. In some cases, these disputes have ended in lawsuits (e.g., Arizona Water Resource, 2000; *Las Vegas Review-Journal*, 2000; and Wheeler, 2000).

The purpose of this study is to explore the various methods states currently employ to handle subsidence losses, including appropriate funding mechanisms. Florida is used as a case study because this state has mandated coverage of its major cause of subsidence but has yet to develop a specific funding mechanism. The first section of the paper discusses the problem of subsidence, including major causes and the impact of the peril. The second section summarizes methods employed to manage the risk of subsidence losses. In addition, the study provides some insight into the potential effectiveness of these systems. Finally, the impact of the various systems on policyholders, insurers, and the general public is discussed.

THE PROBLEM OF SUBSIDENCE

As mentioned above, subsidence can be caused by natural conditions or human activity. Some types of subsidence are more of a problem in specific areas of the country, depending on the weather, population growth, and land usage. This portion of the study discusses three of the major causes of subsidence, some of the problems that have resulted, and the areas most affected. The three causes discussed are depletion of groundwater, mine collapse, and sinkholes. The current state of the sinkhole problem in Florida is discussed in detail.

Depletion of Groundwater

Several southwestern states, including Arizona, New Mexico, California, Nevada, and Texas, are affected by subsidence that is due to groundwater removal. Subsidence generally occurs in these states because the

areas are prone to having fewer surface-level water supplies and have experienced increases in the demand for water because of population growth and agricultural needs (Leake, 1997). This result can be problematic for homeowners, commercial property owners, and whole communities. In Arizona, for example, land subsidence covers more than 3,000 square miles of land in the south-central portion of the state near Phoenix and Tucson (Gelt, 1992). Changes in the level of the land can cause damage to homes, commercial property, streets, and other infrastructure systems such as sewer lines, gas lines, and water mains as well as lead to a disruption of these services and costly repairs.

Some experts indicate that the groundwater subsidence problems in Arizona began in the early 1900s. Withdrawals from the state's groundwater increased dramatically in the 1940s, and by 1984, almost 196 million acre-feet were withdrawn from the alluvial aquifer system. Experts say that the water withdrawals far exceeded the replenishment of the water supply (Gelt, 1992).

Similar problems developed in the Houston, Texas area, where the aquifer system provided a good-quality, inexpensive, easily attainable source of water compared to surface water, which was more expensive and had to be transported into the area. Combined with rapid growth, the convenience and quality of the water source in the area led to an increase in the subsidence problem. As a result, subsidence in the greater Houston area lowered land elevation by at least one foot in a 1,720-square-mile area, making this one of the largest subsidence bowls in the nation (Jensen, 1985).

Mine Collapse

The collapse of mines is another leading cause of subsidence. Salt mines are the primary source of subsidence claims in New York, while the collapse of coal mines drives subsidence claims in Pennsylvania, Kentucky, and Illinois. The collapse of oil and gas mines has resulted in damage in several states, including California, Texas, Louisiana, and Pennsylvania.

Subsidence losses in some of these areas have risen dramatically in the past few years. For example, the Illinois Mine Subsidence Insurance Fund, which oversees the disposition of subsidence-related claims in its state, saw an increase of nearly 65 percent in the number of reported claims between 1998 and 1999. Claims have remained at this level through 2001 (Illinois Mine Subsidence Insurance Fund, 2001).

Unreliable mine maps and records have exacerbated the problems associated with mine subsidence. In Illinois, for example, it was common for the actual area mined to be larger than what was recorded. When subsidence occurred in rural areas, there was rarely structural damage; thus there was little cause for concern. Once these areas were developed,

however, houses and other structures were affected. Prior to 1979, some cities in Illinois tried to mitigate subsidence problems by having the federal government force-fill or grout the mine voids. The process was expensive and the results were questionable. Many local governments did nothing, leaving local residents with no resources to fund the losses (Illinois Mine Subsidence Insurance Fund, 2001). The inaccurate and inconsistent recordings of mines, as well as the inadequate response to the problem by local governments, demonstrated the need for the creation of a uniform means of handling mine subsidence, thus leading to the establishment of the Illinois Mine Subsidence Insurance Fund.

Sinkholes

Sinkholes are a cause of subsidence in states such as Kentucky, Tennessee, and Florida. The state of Florida defines a sinkhole as a "sudden settlement or collapse of the earth supporting such property, but only when such settlement or collapse results from subterranean voids created by the actions of water on limestone or similar rock formations" (Section 627.706, Florida Statutes). Several reasons are cited for the increased occurrence of sinkholes, including rapid population growth and changes in weather patterns. For example, Florida's population increased from nearly 13 million in 1990 to nearly 16 million in 2000.[1] The population growth resulted in development of lands that may already have been susceptible to the peril of sinkholes. Additionally, between 1996 and 2001, there were periods of extreme wet and severe drought conditions.[2] Both conditions increase the likelihood of the occurrence of sinkholes.

The 1992 study of Florida sinkholes found that losses increased in both frequency and severity during the sample period (Butler et al., 1992). To gain an initial perspective on the current impact of sinkhole activity in Florida, this study conducts a survey of sinkhole claims closed between 1996 and 2001 in conjunction with the Department of Insurance.[3] Results are tabulated at the state, regional, and county levels.[4]

Statewide Results

Claim Frequency and Severity—The first portion of the survey addresses the question of whether the frequency and severity of sinkhole claims increases during the sample period. Panel A of Table 1 summarizes the frequency of closed claims during the sample period. Total reported claims increase from 16 in 1996 to 317 in 2001. While the rise is fairly consistent over the entire period, there is a dramatic increase in the number of closed claims between 1999 and 2000.[5] The recent increase in frequency has rekindled an awareness of the problem in the state. As reported in Panel B of Table 1, nearly 81 percent of the paid and compromised claims are the

Table 1. Yearly Disposition and Type of Claims

Panel A: *Disposition of Claims*

Disposition	1996	1997	1998	1999	2000	2001	Total
Paid	7	12	20	29	109	75	252
Compromised	1	0	2	6	7	6	22
Denied	8	4	17	50	223	236	538
Total	16	16	39	85	339	317	812

Panel B: *Types of Paid and Compromised Claims**

Claim Type	1996	1997	1998	1999	2000	2001	Total
Cover collapse	3	6	6	0	6	5	26
Subsidence	2	3	15	33	111	74	238
Clay shrinkage	1	3	2	3	2	5	16
Other	2	0	1	2	5	4	14
Total	8	12	24	38	124	88	294

*In some cases, insurers listed a single sinkhole as multiple types.

result of subsidence sinkholes and approximately 9 percent are cover collapse sinkholes. Insurers paid more than 95 percent of the cover collapse and subsidence claims. The remaining claims are reported under clay shrinkage and other categories.

In addition to the number of claims closed during the period, insurers are asked to report the amounts paid for damage to the structure, land, and other damage as well as allocated loss adjustment expenses, deductibles, and total coverage available in each case. These results are adjusted to 2001 dollars using a historical cost index to allow for an accurate comparison of losses across the sample.[6] The average levels of these loss categories for paid and compromised claims are reported in Table 2. While a fairly steady increase in average payments for damage to the structure is observed, most of the payment categories fluctuate during the period. Land is the exception. This category shows the greatest increase in average payments during the sample period, rising from an average of $2,988 in 1996 to an average of $12,070 in 2001, an increase of more than 300 percent. The rise in payments in this category is particularly interesting since damage to land is traditionally excluded under the homeowners' policy. Perhaps the most

Table 2. Average Payment of Claims Adjusted Using a Historical Cost Index

Average Payment	1996	1997	1998	1999	2000	2001	Average
Structure	$42,809	$47,154	$37,272	$45,000	$43,793	$46,883	$43,819
Land	$2,988	–	$12,559	$18,617	$19,575	$12,070	$10,968
Other	–	$2,630	$2,409	$1,754	$3,008	$2,084	$1,981
ALAE*	$4,039	$8,895	$8,777	$6,342	$5,449	$6,322	$6,637
Deduct	$177	$324	$667	$453	$417	$357	$399
Total	$45,656	$62,458	$80,634	$74,656	$67,374	$62,628	$65,568
Coverage	$98,337	$154,026	$144,303	$108,026	$114,170	$91,844	$118,451

*Allocated loss adjustment expense.

important changes occur in the average loss payments for total claims. During the sample period, the average paid claim increases from $45,656 to $62,628, or approximately 37 percent.

Disposition of Claims—An examination of the disposition of claims suggests that the behavior of insurers has changed during the sample period. Of the 812 claims in the final sample, insurers denied 65 percent. Examining the denial rate per year, the results indicate that the percentage of claims denied increases steadily during the sample period, rising from 50 percent in 1996 to 74 percent in 2001. The years with the highest denial rates, 2000 and 2001, also are the years in which the most claims were filed.

Insurers cited a variety of reasons for denying these claims. These are summarized in Table 3. The most common reason for denial is earth movement not related to the presence of a sinkhole. "Settling, decay, or compression of organic debris" is reported most frequently as the reason for denial, followed by "soil settlement" and "clay shrinkage." Combined, these reasons account for nearly 80 percent of the denials.

Testing Procedures Employed—Testing procedures are important in determining the underlying cause of the earth movement. Insurers reported the use of a variety of testing procedures. In many cases, an insurer employed more than one method in testing for sinkhole activity. During the sample period, the average number of testing procedures used increases for both paid/compromised and denied claims. Based on a means comparison, it does not appear that insurers use a significantly higher number of tests to investigate paid/compromised versus denied

Table 3. Denials by Categories

Denial Reason	1996	1997	1998	1999	2000	2001	Total
Normal soil settlement	4	1	6	22	47	54	134
Clay shrinkage	0	0	3	5	74	55	137
Decay	2	1	4	12	69	65	153
Erosion	1	0	1	1	1	6	10
Faulty construction	1	0	4	1	16	18	40
Other	0	2	1	11	25	23	62
Total	8	4	19	52	232	221	536*

*Two of the claims did not report the reason for denial.

claims. There is evidence, however, that certain testing procedures are used more commonly for claims that are subsequently denied. In addition, the loss adjustment expense is significantly higher for claims that are paid or compromised.[7]

Regional and County Results

The data presented above show that sinkhole claims in the state of Florida are increasing both in frequency and in severity. The data are further examined both regionally and by county to determine if this is a statewide or a regional issue.[8] This is an important distinction, because the way in which insurers and legislators deal with the problem of the increasing number and cost of sinkhole claims will likely depend on whether the problem is dispersed or concentrated.

As shown in Table 4, over 90 percent of the claims occur in the central portions of the state, which include both Tampa and Orlando. On a countywide basis, 40 of the 67 counties in Florida report sinkhole claims during this time period.[9] The counties with the largest number of claims include Pasco, Pinellas, Hillsborough, and Marion, with 154, 119, 75, and 73 closed claims reported, respectively. These counties account for over 60 percent of the sinkhole claims reported in the sample and approximately two-thirds of the claims in which insurers paid some amount. Over half of the counties in the state report fewer than five claims during the sample period.[10]

The disposition of claims by region is reported in Table 5. The table shows that the denial rate varies by region. For example, in the central portion of the state, where most of the claims are concentrated, the denial

Table 4. Reported Claims by Region

Region	1996	1997	1998	1999	2000	2001	Total	Percent
Central	5	1	2	20	128	102	258	32%
Central East	1	0	0	1	12	11	25	3%
Central West	6	13	30	55	147	173	424	53%
North Central	0	0	1	1	15	17	34	4%
Northeast	0	1	2	2	17	3	25	3%
Northwest	0	0	0	4	6	4	14	2%
Southeast	3	0	3	1	8	2	17	2%
Southwest	0	0	0	0	3	5	8	1%
Total	15	15	38	84	333	312	805	

Table 5. Disposition of Claims by Region

Region	Paid	Compromised	Denied	% Denied
Central	61	6	191	74%
Central East	3	0	22	88%
Central West	172	13	239	56%
North Central	8	1	25	74%
Northeast	1	0	24	96%
Northwest	0	0	14	100%
Southeast	4	0	13	76%
Southwest	1	1	6	75%
Total	250	21	534	

rate ranges from 56 to 88 percent. The northern regions have the highest denial rates, with 100 percent of the claims being denied in the northwest.

Summary of Results and Comparison to Prior Closed Claim Study

The problem of sinkholes in the state of Florida has increased in terms of both frequency and severity in recent years. The results of the present survey show a rise in the occurrence of sinkhole claims, which is consistent

with the results of the 1992 survey.[11] In addition, this survey found that the frequency of sinkholes appears to be greatest in the central regions of the state. This finding also is consistent with the results of the 1992 survey and may indicate that, in general, sinkhole losses are a regional issue.

An examination of denial rates for the current survey shows that the proportion of claims denied increased from 25 percent in 1997 to 74 percent in 2001. The denial rate in more recent years is higher than that found in the 1992 survey. The results of the prior survey indicated that the highest denial rate (more than 50 percent) occurred between 1989 and 1991. Both studies found that the reasons for denials have been fairly consistent over the years, with most denials being associated with earth movement other than sinkholes.

MANAGING THE RISK OF SUBSIDENCE

States have devised several methods for managing the risk of subsidence. Commonly used methods include reinsurance facilities, mine reclamation, and government-sponsored insurance. This section discusses the mechanics of these methods as well as how these methods and other alternatives could be implemented in Florida.

Reinsurance Facilities

One method of dealing with subsidence claims is financing the losses through the use of a reinsurance facility. Illinois and Ohio have utilized some form of reinsurance facility for over 15 years. Illinois began to operate the Illinois Mine Subsidence Insurance Fund (the Fund) in 1979. The Fund currently reinsures more than 350,000 policies. The Fund does not write the insurance directly, but acts as a reinsurer for approximately 250 insurers (Illinois Mine Subsidence Fund, 2003b). In the 34 counties designated as most susceptible to subsidence losses, the coverage is automatically included in property contracts. Insureds do have the option to waive the coverage. In all other counties, insurers must make the coverage available to those homeowners who request it. The coverage is inexpensive. Protection of up to $120,000 is available for $50 per year (Illinois Mine Subsidence Fund, 2003a). A maximum of $350,000 of coverage can be purchased for an additional premium. Under this plan, only structures are covered. Though private insurance companies write the coverage, the Fund sets the rates, assists in the underwriting process, and is responsible for investigating and settling losses. In 2000 and 2001, the Fund incurred more than $17 million in residential claims and took in more than $12 million in earned premiums each year. Owing to favorable investment experience during the period

and changes in accounting principles, surplus grew 20 percent in 2001, even with a combined ratio of 108 percent for residential losses (Illinois Mine Subsidence Insurance Fund, 2001).

Ohio's reinsurance facility differs from that of Illinois in several respects. The Ohio Mine Subsidence Fund (OMSF) and the Ohio Mine Subsidence Insurance Underwriting Association (OMSIUA) were established in the mid-1980s. The OMSF was originally financed by the state and federal governments, but now operates as a reinsurance facility. Like the Illinois Mine Subsidence Fund, the OMSF has designated that coverage be mandatory in certain counties and requires insurers to make it available in several other counties. However, the premium structure is quite different. The maximum coverage available is $50,000 or the value of the home, whichever is less. While the initial legislation set maximum premiums at $5 in mandatory counties and $20 in other counties, the Mine Subsidence Board of Governors has since lowered the cost of the policies. The current cost is only $1 in the mandatory counties and $5 in the other counties. Coverage is limited to damage to the dwelling, and losses are settled on an actual cash value basis. Like the Illinois Mine Subsidence Fund, the OMSF sets rates, whereas the OMSIUA is responsible for investigating claims. The Ohio FAIR Plan Underwriting Association (OFPUA), however, handles claims administration.

Between 2000 and 2001, the OMSF received more than 200 new claims and paid more than $1.3 million in existing claims (Ohio Mine Subsidence Insurance Underwriting Association, 2001). The OMSF currently insures more than 600,000 homeowners through member insurers (Ohio Insurance Institute, 2003). According to the Ohio Mine Subsidence Insurance Underwriting Association's annual report, its fund balance has remained in excess of $11 million since 2000. Disbursements from the OMSF in 2002 were approximately $724,000, compared to approximately $636,000 in 2000 (Ohio Mine Subsidence Insurance Underwriting Association, 2001; Deters, 2002). Indiana and Kentucky make use of reinsurance facilities with structures similar to those of Illinois and Ohio (Legislative Services Agency, 2001; Kentucky Department of Insurance, 2001).

Mine Reclamation

The Surface Mining Control and Reclamation Act of 1977 created the National Association of Abandoned Mine Land Programs (NAAMLP), which currently has 30 member states and tribes.[12] The states receive government appropriations from the Office of Surface Mining Reclamation and Enforcement (OSMRE) to fund state-run programs. Appropriations are obtained from the industry. For example, more than $1 billion has been collected from the Wyoming coal industry since the inception of the

NAAMLP. Wyoming has spent the majority of the $333 million appropriated by the OSMRE on reclaiming mines, with a portion spent assisting public facilities affected by mine subsidence (Wyoming's Department of Environmental Quality, 1998).[13]

In addition to providing funds for mine reclamation, the NAAMLP serves several other purposes, one of which is the sharing of information. As declared in its mission statement, the NAAMLP provides "a forum to address current issues, discuss common problems, and share new technologies regarding the reclamation of abandoned mine lands" (National Association of Abandoned Mine Land Programs, 2002). Besides this service, the NAAMLP also works with other organizations, including the Interstate Mining Compact Commission, on the effective use of natural resources and other common issues.

Pennsylvania, Kentucky, and Indiana all have had success with mine reclamation projects. These projects can be costly and time consuming and are not always funded entirely by the NAAMLP. For example, one Kentucky project cost close to $900,000 and took approximately 10 months to complete. The Appalachian Clean Stream Initiative provided more than 60 percent of the cost of the project (National Association of Abandoned Mine Land Programs, 2002).

Pennsylvania established an initiative called Reclaim PA through the Bureau of Abandoned Mine Reclamation. The initiative is projected to cost the state approximately $15 billion (Pennsylvania Department of Environmental Protection, 2002a). In Indiana, the Division of Reclamation falls under the Department of Natural Resources. Coal operators pay a $.03 per ton reclamation fee on mined surface coal to provide 12.5 percent of the division's budget. Revenue from the general fund and federal grants are the other main source of the division's budget (Access Indiana, 2003).

Government Intervention

In Texas, subsidence due to the depletion of groundwater is being mitigated through a type of loss control implemented by the Texas Legislature. In 1975, Article XVI, Section 59, of the Texas Constitution created the Harris-Galveston Coastal Subsidence District by what is commonly known as the "Conservation Amendment." The District reviews permits for groundwater use with respect to the relative effect of a particular pumping on subsidence and other factors. As a result of the District's efforts, groundwater depletion has slowed and the level of subsidence has been reduced (Jensen, 1985).

The state of Pennsylvania takes a different approach to protecting property owners against the peril of subsidence. In addition to mine reclamation, Pennsylvania created the Mine Subsidence Insurance Fund in

1961. The Mine Subsidence Insurance Fund is a nonprofit fund that offers insurance directly to homeowners and is administered by the Mine Subsidence Insurance Board, which is part of the Pennsylvania Department of Environmental Protection.[14] Coverage is offered up to $150,000 at a cost of approximately $1 per $1,000 of coverage for homeowners and covers only structures. In addition, the Mine Subsidence Insurance Fund oversees the investigation and settlement of claims (Pennsylvania Department of Environmental Protection, 2002b).

One benefit of both the reinsurance facilities and the Pennsylvania Mine Subsidence Insurance Fund is the uniform handling of claims. Since these facilities and funds are responsible for the investigation and settlement of claims, either directly or through some third party, the procedure is the same for all policyholders. The investigators have developed experience in this area and use consistent testing and evaluation procedures. Problems associated with inconsistent determination of the nature of the subsidence should be reduced with experienced investigators, thus providing a further guarantee that policyholders receive equal treatment regardless of the coverage provider.

Extending Solutions to the Peril of Sinkholes in Florida

As shown in the previous section, sinkholes have been a recurring problem in Florida for many years. The trends of increasing sinkhole claim frequency and severity are likely to continue. In 1969, the state of Florida developed a reinsurance facility to provide coverage for the peril of sinkholes. The coverage was optional and very few policyholders elected to purchase it. The program was consequently abolished. Currently, coverage for the peril of sinkholes is a mandated coverage in insurance policies covering structures in Florida.[15]

Given the growing cost of the problem, a specific funding solution is needed in the near future to create a uniform method of financing losses associated with this peril. One option for financing potential sinkhole losses is to establish a government-sponsored insurance program that would provide coverage for sinkhole losses or to create an organization to provide coverage specifically for the peril of sinkholes. This option is currently being used in Pennsylvania. Government-sponsored insurance also has worked effectively for coverages such as health insurance (Freedman, 1987) and flood insurance. This option would make insurance available to those in areas where sinkhole losses are most likely to occur. The benefit of this option is that the government-sponsored insurance may be more affordable than private insurance. The downside is there would likely be requirements that homeowners and/or communities would have to meet in order to be eligible for the coverage. For example, with the National

Flood Insurance Program, coverage is available only in communities that agree to design and implement floodplain management ordinances.[16]

Another alternative is to create a reinsurance facility. This option has been used in the past for health insurance and natural disasters (e.g., Hall and Lawlor, 2001; Grace, Klein, and Phillips, 2001; Reinsurance Association of America, 2001). As discussed above, reinsurance facilities are currently being used in several states to deal with subsidence losses. One primary benefit of this method is that the reinsurance facilities in some of these states not only provide a means of financing subsidence losses, but also investigate the claims for validity. If a system similar to that used in Illinois or Ohio is adopted in Florida, it not only will establish a mechanism to pay for sinkhole claims, but also will increase the consistency with which these claims are investigated. Because cover subsidence losses develop gradually and can be difficult to identify, this is an important issue. The gradual settling of a structure also can result from a multitude of other perils, such as pipe clay settlement, organic material settlement, or animal activity. As noted in a recent article in the *Florida Underwriter*, only a few firms currently have the capability to investigate and determine the occurrence of sinkholes (Galewitz, 2002). The significant variation in testing procedures found for paid/compromised claims when compared to denied claims suggests that currently, there is no consistent method of testing for sinkhole claims in Florida. This may be driving up the cost of investigations and, therefore, increasing the cost of settling claims.

A last option is to allow insurance companies in Florida to begin to rate for the peril of sinkholes. A potential problem with this option is that enough data must exist to create a fair and credible rating factor. Insurers faced similar problems in the early years of underwriting automobile and medical malpractice insurance (e.g., Ellis, Gallup, and McGuire, 1990; Samson, 1986; Stroinski and Currie, 1989; Tryfos, 1987). In some cases, such as with medical malpractice insurance, this issue has not been completely resolved.

CONCLUSION

As the development of new land, mining, groundwater removal, and severe wet and dry conditions continue in the United States, it is likely that the economic significance of subsidence will continue to grow. In most cases, the effects of subsidence are irreversible. Thus, changes in the topography of the land caused by subsidence can have repercussions for future property owners. In 1961, for example, Hurricane Carla flooded 146 square miles of land in Texas. If a similar storm had struck the same area 20 years

later, researchers estimate the flooding would have covered an area 25 square miles larger because of the impact of subsidence (Jensen, 1985).

Though subsidence has been identified as a problem in many states, not all of the affected states have a mechanism in place to handle it. In Florida, though coverage is mandated in standard property contracts, no funding mechanism has been established. The results of the current sinkhole survey show that more than 80 percent of the sinkholes occurring during the sample period occurred in the central portion of the state. As a result of the current lack of a funding mechanism, property owners in other counties are effectively subsidizing the coverage of property owners in the counties of the affected regions. Since research in this area is limited, a complete assessment of the extent of the subsidization cannot be conducted.

The methods outlined above provide viable alternatives to the problem of subsidence-related losses. Whether states use a preventive, restorative, or continuous funding approach can severely affect the cost borne by society. For example, the use of permits for water usage in the state of Texas is a low-cost method of preventing the likelihood of future losses resulting from groundwater depletion. In contrast, the restorative Reclaim PA project currently underway in Pennsylvania is estimated to cost the state, and thus the residents, approximately $15 billion. The continuous funding approach, either through a reinsurance facility or government-sponsored insurance, has several advantages, primarily the low cost to property owners and the uniform handling of claims. The low cost makes it affordable to many homeowners, and the mandated offering of coverage in certain counties guarantees that those homeowners who need the coverage have access to it. The uniform handling of claims ensures that costs are minimized and increases the likelihood that the testing procedures, evaluation, and claims decisions are consistent for all homeowners. Regardless of the funding method chosen by the state of Florida and other states, it is clear that the problem of subsidence losses must be addressed sooner rather than later to ensure the preservation of natural resources, the profitability of insurers, and the consistent settlement of claims for property owners.

NOTES

[1] Population figures taken from the Bureau of Census.

[2] Based on charting the Palmer Drought Severity Index (PDSI) for Florida, a soil moisture algorithm that provides a standardized measurement of wet and dry conditions (Palmer, 1965).

[3] The electronic survey requested information on all closed sinkhole claims occurring in Florida between 1996 and 2001. Insurers were asked to provide general information on the location

of the claim by zip code, the date the loss was reported, and the date the claim was closed, as well as specific information related to testing procedures, disposition of claims, and total payments made by categories. A copy of the survey can be found in Appendix A. The survey was distributed to insurers operating in Florida through the Property Committee of the Florida Insurance Council. Of the 16 entities writing homeowners insurance that received the survey, 8 responded. Of the 877 closed claims received, 812 are useable. Thirty-six observations were removed either because the insured withdrew the claim or because there was no contact from the insured. An additional 29 claims were removed because the final disposition of the claim or some other crucial information was not provided. State-, regional-, and county-level analyses were conducted. The timeframe of the study was limited by the availability of the data from participating insurers.

[4] The results presented are a summary of the information provided by Florida insurers. The study reports observed patterns in changes in the number of closed sinkhole claims. Reasons for the underlying changes are not addressed with the survey information.

[5] While these numbers are based on a sample of homeowners insurers in the state of Florida, the sample does represent a consistent portion of the homeowners premium earned through the sample period. Thus, the increase in claims does not appear to be driven by an increase in the market share of the firms in the dataset.

[6] Historical cost indexes are obtained from the R.S. Means *Building Construction Cost Data* (2003).

[7] Because of data limitations, the authors are unable to test for differences in the actual costs of the various testing procedures. Results related to the types of testing procedures are available from the authors upon request.

[8] Appendix B outlines the counties included in each region.

[9] The following counties reported no claims during the sample period: Baker, Calhoun, Collier, De Soto, Dixie, Flagler, Franklin, Gadsden, Glades, Gulf, Hamilton, Hardee, Hendry, Holmes, Jefferson, Lafayette, Liberty, Madison, Martin, Monroe, Okeechobee, St. Lucie, Taylor, Union, Wakulla, Walton, and Washington.

[10] Of these counties, only three reported any claims in which the insurer paid. Interestingly, nearly half of all counties reporting claims had denial rates of 100 percent. In terms of severity, Lee, Seminole, Leon, and Hillsborough had the highest average claims payments. County tables are available from the authors upon request.

[11] This study does not include the years beginning immediately after the other sample, because the data were not available. Though the exact pattern of sinkhole losses from 1992 to 1995is unknown, it is possible that the variation in weather conditions between the two sample periods provides a partial explanation for the drop in claims. The increase in claims frequency during both sample periods is a major factor in the timing of the interest in the sinkhole problem by the Florida Department of Insurance, which commissioned both studies.

[12] Alabama, Alaska, Arizona, Arkansas, Colorado, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Missouri, Montana, New Mexico, North Dakota, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Utah, Virginia, West Virginia, and Wyoming all are member states. Crow, Hopi, and Navajo are the only member tribes.

[13] In addition to the purchase of abandoned mines, a portion of the more than $1 billion collected has gone to the establishment of the mine subsidence insurance program.

[14] The state's Mine Subsidence Insurance Program is currently supported by premiums, though initial funding was obtained by appropriation from the state legislature in 1961 (The General Assembly of Pennsylvania, 1974). Since 1998, assets in Pennsylvania's Coal and Clay Mine Subsidence Insurance Fund have increased from just over $26.5 million to more than $36.7 million. The fund currently has almost $3 million reserved for catastrophes (Pennsylvania Department of Environment Protection, 2003).

[15] Section 627.351(3), Florida Statutes (1969) (later repealed) and Rule Chapter 5-23, Florida Administrative Code (later renumbered to Rule Chapter 4-23).

[16] For information on requirements related to the National Flood Insurance Program, see http:fema.gov/nfip.

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APPENDIX A

Survey

General Information
- Zip code
- Date loss reported
- Date loss closed

Type of Claim (select one)
- Sinkhole (cover collapse)
- Sinkhole (subsidence)
- Clay Shrinkage
- Other
- Other (specify)

Any Priors?
- Yes
- No

Action Taken—Tests (select all that apply)
- Shallow boring
- Deep boring
- Ground penetrating radar
- Site inspection
- Other
- Other (specify)

Disposition of Claim
- Paid in full
- Compromised
- Denied

If Denied, Why?
- Normal soil settlement
- Clay shrinkage
- Settling, decay or compression of organic debris
- Faulty construction
- Other
- Other (specify)

Indemnity Payment
- Structure
- Land
- Other
- Deductible
- Total
- Allocated loss adjustment expense

Amount of Coverage

APPENDIX B*

County/Region List

Central
Marion
Sumter
Lake
Seminole
Orange
Osceola
Polk
Hardee
Highlands

Central East
Volusia
Brevard
Indian River
Okeechobee
St. Lucie

Central West
Citrus
Hernando
Pasco
Pinellas
Hillsborough
Manatee
Sarasota
De Soto

North Central
Gadsden
Leon
Wakulla
Jefferson
Madison
Taylor
Hamilton
Suwanee
Lafayette
Dixie
Columbia
Union
Bradford
Gilchrist
Alachua
Levy

Northeast
Baker
Nassau
Duval
Clay
St. Johns
Putnam
Flagler

Northwest
Escambia
Santa Rosa
Okaloosa
Walton
Holmes
Washington
Bay
Jackson
Calhoun
Liberty
Gulf
Franklin

Southeast
Martin
Palm Beach
Broward
Dade
Monroe

Southwest
Charlotte
Glades
Lee
Hendry
Collier

*Classification based on www.floridacountiesmap.com.