Embrace a Gift of Nature: A Proposal for Commercializing Natural Eco-Dyes for the Textile Industry

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ABSTRACT

Textile dyes and the dyeing process are a significant, but often highly ignored, contributor to environmental pollution. This Article explores the nexus between law and policy regarding textile dyes, dyeing, and their environmental consequences. A recent study shows that the industry uses 1.3 million tons of synthetic dyes, mostly in the United States, India, China, and Bangladesh. Textile dyeing is an extremely hazardous process that generates a massive amount of toxic waste that pollutes our water, air, and land; harms human health; and degrades the overall environment. Law and policy based on the prevention and mitigation model (or resources-to-recovery model) has changed the landscape of the textile industry not only in the United States, but also in India, China, and Bangladesh. This paradigm is ineffective to control textile pollution.

This Article advocates and proposes the revolutionary commercialization of eco and natural dyes by embracing plant-based dyes, which have little to no harmful effects on human health and the environment. To that end, this Article advocates that a global environmental revolution is needed—we must direct our effort to the "resources-to-resources model" by adopting natural and plant-based eco-dyes to save the people, save the environment, save the nation, and save Planet Earth. Under the resources-to-resources model, the textile industry would generate no pollution because natural plant-based dyes have no known harmful effects on human health and the environment.

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INTRODUCTION

One court said, "Man's ability to alter his environment has developed far more rapidly than his ability to foresee with certainty the effects of his alterations."[1] Professor Robert Percival argues that "in the past 50 years we have added more people and more pollutants to the planet than in the preceding 10,000 years."[2]

Indeed, textile manufacturing has earned the title as one of the world's most highly-polluting industries.[3] A study from China shows that manufacturing one cotton T-shirt requires 2,700 liters of water.[4] For many decades, the textile industry has been consuming tons of synthetic dyes[5] and auxiliaries worldwide.[6] These synthesized dyes are derived from petroleum and coal tar.[7] In the end, about 20 percent of all fresh water pollution is caused by textile chemicals worldwide.[8]

According to recent data, the textile industry uses a substantial variety of commercially available dyes.[9] The chemical industry produces over 0.7 million tons of dyes annually.[10] As a result, the industry generates a significant amount of complex and non-degradable toxic dye effluents, hazardous air pollutants, and

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1. *See generally*, ROBERT V. PERCIVAL ET AL, ENVIRONMENTAL REGULATION, LAW, SCIENCE, AND POLICY (8th ed. 2018); *see also* Ethyl Corp. v. E.P.A., 541 F.2d 1, 6 (D.C. Cir.) (Judge Skelly Wright), *cert denied* 96 S. Ct. 2662, 2663 (1976).

2. PERCIVAL ET AL., *supra* note 1, at 3.

3. *See* Jenny Lei Revelo, *Mapping the Environmental Impacts of China's Textile Industry*, DEVEX, (Jan. 18, 2018), https://perma.cc/RJZ4-JHXS, (last visited Aug. 29, 2019).

4. *See* CHINA WATER RISK, Today's Fight for the Future of Fashion: Is There Room for Fast Fashion in a Beautiful China? 3 (2016), *available at* https://perma.cc/7U9L-UPMK.

5. *See, e.g.*, Avecia, Inc. v. United States, 469 F. Supp. 2d 1269, 1289 (Ct. Int'l Trade 2006) (defining dyes as "synthetic organic coloring matter"); Amendment To Clarify When Component Part Testing Can Be Used and Which Textile Products Have Been Determined Not To Exceed the Allowable Lead Content Limits, 80 Fed. Reg. 61729, 61731 (Oct. 15, 2015) (to be codified at 40 C.F.R. pt. 1500).

6. *See* Emhart Indus., Inc. v. New England Container Co., 130 F. Supp. 3d 539, 543 (D.R.I. 2015) (showing that other substances may include raw materials used in connection with the manufacture of many products, such as alcohols, formaldehyde, urea, sulfur trioxide, and metal salts.).

7. *See Doing Business in Maharashtra, Dyestuff Sector*, MAHARASHTRA ECONOMIC AND DEVELOPMENT ASSOCIATION. ORG., available at https://perma.cc/SZN4-E9MU [hereinafter Maharashtra REPORT] (last visited May 8, 2019). *But see*, Travelers Indem. Co. v. MTS Transp., LLC, No. 11-CV-01567, 2012 WL 3929810, at *16 (W.D. Pa. Sept. 7, 2012).

8. *Various Pollutants Released into Environment by Textile Industry*, FIBRE2FASHION, https://perma.cc/G4ZD-YRWP (last visited May 8, 2019) [hereinafter POLLUTANTS RELEASED BY TEXTILE INDUSTRY].

9. *See, e.g.*, SANJAY K. SHARMA, GREEN CHEMISTRY FOR DYES REMOVAL FROM WASTE WATER: RESEARCH TRENDS AND APPLICATIONS 11–12 (2015) (describing technologies used for color removal, including biological and physical methods); Amit Dayal & Ajay Sardana, *Dope-Eyed Fibres: A Solution to Environmental Pollution*, FIBRE2FASHION, https://perma.cc/SM35-DXQR (last visited May 8, 2019).

10. See id.; Swapnil K. Kale, *Decolorization and Wood Degrading Ability of Locally Isolated Basidiomycetes*, 73 J. OF SCIENTIFIC & INDUSTRIAL RESEARCH 735, 735 (2014) ("Worldwide approximately 10,000 different dyes and pigments are used industrially, and over 0.7 million tons of synthetic dyes are produced annually"); Himani Sharma & Poonam Shirkot, *Bioremediation of Azo Dyes Using Biogenic Iron Nanoparticles*, 7 J. OF MICROBIOLOGY & EXPERIMENTATION 12, 12 (2019), available at https://perma.cc/9JXT-DHPN ("The world market for dyes, pigments and dye intermediates is estimated at about US $23 billion consisting of dyes and pigment market of 1.3 million tones.").

solid wastes, which have harmful health effects, particularly in the United States, India, China, and Bangladesh.[11]

Additionally, dye consumption in the textile industry raises various concerns at the global level because the industry uses a significant amount of water, toxic dyes, crease resident agents, anti-shrinking agents, oil, soil and water repellants, stabilizers, plastics, flame retardants, and reactive resins for finishing treatments.[12] The Government of India says that the global chemical industry is estimated to be worth more than U.S. $2.4 trillion, and is one of the fastest growing sectors of the manufacturing industry.[13] Many of these dyes' effluents have persistent, toxic, and bio-accumlative characteristics.[14]

Environmental law addresses some concerns relating to degradation of our natural resources by textile chemicals. Chemical regulations in the United States and abroad are tied to the "resources-to-recovery model."[15] Under the resources-to-recovery model, we exploit our natural resources and legislatures and government agencies enact laws to help recover from this damage.[16] The Resource Conservation and Recovery Act ("RCRA"),[17] the Toxic Substances Control Act ("TSCA"),[18] the Emergency Planning and Community Right-to-know Act ("EPCRA"),[19] and all other laws and regulations fall within this model.[20]

Since synthetic dyes involve both organic and inorganic substances, alternative resources such as natural eco-dyes present a viable substitute to avoid the harmful

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11. See ENVIRONMENTAL ASPECTS OF TEXTILE DYEING xii (R. M. Christie ed., 2007) (describing the harmful effects of synthetic dyes) [hereinafter Christie]. *See infra* Part III.

12. *See* Christopher Bell, *Product Stewardship and Textiles*, E2 LAW BLOG (Apr. 27, 2017, 9:08 AM), https://perma.cc/3T9V-Q82N ("Vietnam just relaxed its chemical testing rules for exported textiles (e.g., textiles and apparel exported to the U.S. and EU markets), specifically for formaldehyde and aromatic amines.").

13. *See* GOVERNMENT OF INDIA, INDIAN CHEMICAL INDUSTRY – XIITH FIVE YEAR PLAN, at 4, 14, *available at* https://perma.cc/V5A6-K2XT.

14. *See infra* Parts II, III.

15. *See infra* Part I.

16. *See infra* Part I.

17. *See* Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901 – 6992k (2019); U.S. ENVIRONMENTAL PROTECTION AGENCY, RCRA IN FOCUS: TEXTILE MANUFACTURING, at 1, *available at* https://perma.cc/768D-LQ7L [hereinafter EPA's RCRA FOCUS] ("Wastes are defined as hazardous by EPA if they are specifically named on one of four lists of hazardous wastes or if they exhibit one of four characteristics (characteristic wastes).").

18. *See, e.g.*, PERCIVAL ET AL., *supra* note 1, at 269–70 (explaining TSCA regulation before and after it was amended in 2016); THOMAS F. P. SULLIVAN, ENVIRONMENTAL LAW HANDBOOK 853–55 (23d ed. 2017); Toxic Substances Control Act, 15 U.S.C. §§ 2601 – 2697, as amended by the Lautenberg Chemical Safety for the 21st Century Act (2016). Note: In this Article, author has considered only the New TSCA (as amended).

19. Clean Air Act, 42 U.S.C. §§ 7401 – 7431 (2018); See James R. May, *The Real Acid Test of Title IV of the Clean Air Act Amendment of 1990: Extra Cost Justifications Not Related to Acid Deposition Control*, 3 FORDHAM ENVTL. L. REV. 97, 113–14 (1992) (stating that dyes, paints, and textile fabric may increase NO_x in the atmosphere).

20. *See, e.g.*, Rules and Regulations Under the Textile Fiber Products Identification Act, 67 Fed. Reg. 70835 (Nov. 27, 2002) (codified at 40 C.F.R. pt. 300).

effect of the synthetic dyes.[21] Eco-dyes are derived from many indigenous plants, fruits, leaves, stems, seeds, roots, flora and fauna, and waste generated from many sources, which offers a promising future for sustainable development of natural textile dyes and dyeing.[22] Usually, natural dyes are renewable, sustainable, bio-sourced products with little to no environmental consequences.[23] To that end, many small-scale firms have made revolutionary efforts to promote the environmentally-friendly, non-toxic, botanical, and efficient eco-dyes for the textile industry.[24] Lately, much scientific research on natural dyes has been conducted to boost this revolution.[25] Despite the vast scientific evidence to incorporate natural, eco-dyes in the commercial textile industry, federal and state governments, regulatory agencies, legal scholars, and commercial textile manufacturers have not made steps towards a resources-to-resources reform.[26]

Historically, the textile industry used only natural eco-dyes in the production of textile dyes and auxiliaries.[27] Therefore, in earlier times, the resources-to-resources model existed and was widely used.[28] Under this model, we would use our natural resources, rather than chemicals, in the textile industry, thereby minimizing harm to natural resources, human health, and the environment.[29] Additionally, the waste generated through the use of natural resources can be safely returned to nature without harming nature (resources) itself.

A global environmental revolution towards the resources-to-resources model is needed because the resources-to-recovery model, when used as a mitigation and prevention regime, is not at all sufficient to unwind the torment caused by

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21. *See id*. The organic and inorganic dyes are derived from petroleum and coal tar-based products.

22. *See infra* Parts III–IV

23. *See generally* INDIA FLINT, ECO COLOUR: BOTANICAL DYES FOR BEAUTIFUL TEXTILES 26 (2008) (describing that "[d]yes from plants area renewable resources, whereas synthetic dyes derived from petroleum or fossil sources, such as coal, are not."). *But see* Asim Kumar & Roy Choudhury, *Eco Friendly Dyes and Dyeing*, 2 ADVANCED MATERIALS & TECH. FOR ENVTL. APPLICATIONS 145, 163–65 (2018). *See infra* Part IV.

24. *See generally*, FLINT, *supra* note 23; Mini Muringatheri, *The KAU Identifies 12 Natural Dyes for Textile*, THE HINDU, Aug. 30, 2017, *available at* https://perma.cc/WKT8-U7PV ("The research has opened up the possibility of using indigenous plants of Kerala as potential dye yielders. We are looking forward to industrial production of natural dyes for commercial textile industry . . . ."). *See infra* Part IV.

25. *See, e.g.*, Sivaji Ganesan, *Eco-Friendly Natural Dye from Bark of Acacia Leucophloea for Dyeing of Cotton Fabric Using Different Temperature and Mordant*, 10(1) S. ASIAN J. OF RES. IN CHEMISTRY 1, 1 (2017) (explaining that natural dyes minimize the level of environmental pollution and substantiate the nutritional value of the land); Taame Berhanu & Saminathan Ratnapandian, *Extraction & Optimization of Natural Dye from Cassia Singueana Plant Used for Coloration of Tanned Leather Materials*, 2017 ADVANCES IN MATERIALS SCI. & ENG'G 1, 5 (2017) ("[D]ye extracted from bark of [Mango and Aloe Vera] can be used as dye for coloring of tanned leather. Abundant availability in Ethiopia makes the raw material cheap. The use of this plant for coloration of leather would reduce import of synthetic dyes.").

26. *See* Bell, *supra* note 12 ("The presence of these chemicals in textiles is relatively unregulated at the federal level in the United States, though there has been some attention at the state level.").

27. See CHRISTIE, *supra* note 11, at 45.

28. *See infra* Part IV.

29. *See infra* Parts III–IV.

textile dyes.[30] This Article explores the use of synthetic chemicals used in the textile industry and advocates for an alternative approach.

In Part I, the Article discusses regulatory burdens in the United States, India, China, and Bangladesh. The Article emphasizes legal jurisprudence and applicable laws in these countries. The Article argues that all established laws under the resources-to-recovery model are not effective for the textile industry. In Part II, this Article highlights the key issues with textile dyes by engaging in an in-depth chemical analysis of the process used in textile dyes and dyeing. This Part explains the heart of the issue by discussing chemical toxicology and classification of synthetic dyes. In this Part, the predominant discussion is focused on chemicals used in an eight-step textile dyeing process and the resulting hazardous effluents that are left over in dyebaths. In Part III, this Article discusses the factual challenges associated with textile chemicals in the United States, India, China, and Bangladesh. In Part IV, the Article introduces an alternative type of textile dye that would not harm health and the environment, but rather uses natural resources under the resources-to-resources model. In this Part, the Article discusses how to develop long-term sustainability in the dyes and textile dyeing process. Then the Article summarizes legal jurisprudence in regulating natural eco-dyes under the resources-to-resources model. It discusses the revolutionary efforts have been made so far and their outcomes. Finally, the Article compares the resources-to-recovery model against the resources-to-resources model and proposes commercializing natural eco-dyes as a better alternative.

I. LEGAL CHALLENGES: SUMMARY OF LEGAL JURISPRUDENCE IN REGULATING THE TEXTILE INDUSTRY UNDER THE RESOURCE TO RECOVERY MODEL

A. REGULATING TEXTILE CHEMICALS IN THE UNITED STATES

Based on a historical and empirical study, many of the current U.S. environmental laws came into existence to regulate pollution or came in response to some incident or event that required mitigating the damages caused by the unregulated exploitation of resources[31]—the resources-to-recovery approach. Interestingly, today's textile industry is one of the most chemical-intensive industries. Professor Walker explains that "from the 1970s to 1990s, environmental law generally consisted of natural resource management . . . . Consequently, the resource itself has not been protected so much as the interest in deriving revenue

30. *See* SULLIVAN, *supra* note 18, at 6 ("[O]ur major federal environmental statues define most of substantive compliance obligations for the environmental law system . . . . [T]here are other components of environmental laws that supplement or complement the program that the federal environmental statutes establish . . . ."); Bell *supra* note 12 (stating that "[p]erhaps more importantly than formal regulation, the chemical content of apparel, including formaldehyde, receives a certain amount of attention in social media.").

31. *See* Robert V. Percival, *Who's Afraid of the Precautionary Principle?*, 23 PACE ENVTL. L. REV. 21, 57 (2005–2006).

from the resource."[32] Furthermore, the past few years have brought a torrent of toxic chemicals cases regarding the use of phenols,[33] tetrachloroethylene,[34] hydrofluorocarbons ("HFCs"),[35] hexavalent chromium,[36] polychlorinated biphenyls ("PCBs"),[37] per-and polyfluorinated alkyl substances ("PFAS"),[38] and formaldehyde.[39] Since these chemicals are widely used by the textile industry, it is necessary to address a number of shortcomings and pitfalls under the resources-to-recovery model.[40] This Article explains how the resources-to-recovery model deals with the effects of synthetic dyes and dyeing in the textile industry and how it enables us to prevent harm to the environment and human health.

1. The Toxic Substance Control Act—Frank R. Lautenberg Chemical Safety for the 21st Century Act ("TSCA")

The textile chemicals, including dyes, are regulated under TSCA. Congress enacted TSCA in the wake of the "Kepone incident" in West Virginia.[41] Since

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32. Michael J. Walker & Jon D. Jacobs, *EPCRA Citizens Suits: An Evolving Opus with a Discordant Note*, 7 J. OF ENVTL. L. & PRAC. 15 (Jan/Feb. 1997).

33. Application of Burckel, 592 F.2d 1175, 1179 (C.C.P.A. 1979) (discussing that phenolic substances can be used to prepare fabric); CENT. POLLUTION CONTROL BD, PHENOLS & PHENOLIC COMPOUNDS 2 (2016), https://perma.cc/K6GS-WW2K. *See infra* Part II.

34. *See* In re Methyl Tertiary Butyl Ether (MTBE) Products Liability Litigation, 725 F. 3d 65, 89 n.6 (2d Cir. 2013) ("Perchloroethylene (also known as 'PCE,' 'perc,' or tetrachloroethylene) is a solvent used in . . . textile processing industries.").

35. *See, e.g.*, PERCIVAL ET AL., *supra* note 1, at 1227 ("[A]lthough companies were initially permitted to replace CFCs and other ozone depleting substances with HFCs, in 2015, EPA moved HFCs to the prohibited list."). *See infra* Part II.

36. *See, e.g.*, Leather Industries of America, Inc. v. EPA, 40 F.3d 392, 405–408 (D.C. Cir. 1993) (describing how hexavalent chromium that remains as an effluent can be toxic and contaminate the soil); Abrogast v. Timex Corp., No. 05–2076, 2010 WL 148288, *4–*7 (explaining that in leather tanning, hexavalent chromium is used); Priti Sharma et al., *Groundwater Contaminated with Hexavalent Chromium [Cr (VI)]: A Health Survey and Clinical Examination of Community Inhabitants (Kanpur, India)*, PLOS ONE (2012), https://perma.cc/KZD6-UDH3 (arguing that chromium hexachlorides are widely used by leather tanneries in India); SULLIVAN, *supra* note 18, at 830 (describing that hexavalent chromium is regulated under TSCA's chemical specific regulation).

37. *See, e.g.*, CTRS. FOR DISEASE CONTROL & PREVENTION & NAT. INST. FOR OCCUPATIONAL HEALTH AND SAFETY, CURRENT INTELLIGENCE BULL. NO. 45, POLYCHLORINATED BIPHENYLS (PCB's) (1986) https://perma.cc/4LJZ-Q5ZK; Gen. Elec. Co. v. Joiner, 522 U.S. 136, 139–40 (1997) (holding that dioxin and PCB can cause cancer); SULLIVAN, *supra* note 18, at 830 (describing how PCB is regulated under the banner of chemical specific regulation under TSCA).

38. *See infra* text and accompanying notes 114–24, 140–44.

39. See, e.g., *Formaldehyde in Clothing and Textiles*, AUSTL. GOV'T DEP'T OF HEALTH, https://perma.cc/R6BF-RMKD (last visited Oct 1, 2019); *Hearing Before Subcommittee on Consumer Protection, Product Safety, and Insurance*, U.S Committee on Com., Sci., and Transportation (2018), available at https://perma.cc/B64K-SU4M; Bell, supra note 12. *But see* ROBERT V. PERCIVAL & CHRISTOPHER SCHROEDER, ENVIRONMENTAL LAW STATUTORY AND CASE SUPPLEMENT 162–66 (2018–2019) (showing that formaldehyde is regulated under TSCA §2697 (subchapter VI) but this regulation applies to wood products and not textile products).

40. New York v. Shore Realty Corp., 759 F2.d 1032, 1038 (2d Cir. 1985).

41. *See* Moore v. Allied Chem. Corp., 480 F. Supp. 364, 367–68 (E.D. Va. 1979). In Moore, the federal government banned production of Kepone for the most part, which Allied used extensively in

TSCA's enactment in 1976, Congress has amended TSCA only a few times, and those amendments were minor amendments compared to its most recent amendment in 2016.[42] In 2016, TSCA grandfathered approximately 62,000 existing chemicals, but the act failed to provide a mandate for the United States Environmental Protection Agency ("EPA") to assess the chemicals for health and safety.[43] While EPA has evaluated some of these chemicals, many others have yet to be studied.[44]

Under the current TSCA, EPA is authorized to evaluate and ensure the safety of all chemical substances in U.S. commerce and designate them as either high priority or low priority for further assessment based on prioritization, risk evaluation, and risk management.[45] To that end, TSCA places the responsibility on the manufacturers[46] to provide data on health and environmental effects. TSCA also gives broad authority to EPA to regulate use, distribution, and disposal of chemical substances.[47] TSCA authorizes EPA to determine whether a new chemical substance or a new chemical substance's significant new use will likely present an unreasonable risk of injury to human health or the environment (EPA's foreseeability and reasonableness findings).[48]

Importantly, EPA has the discretion to determine whether to proceed or not because TSCA requires only EPA's foreseeability and reasonableness findings in making that determination.[49] For example, under § 4, TSCA authorizes EPA to perform risk evaluation of any substance that EPA concludes is a high priority under § 6(b).[50] Additionally, TSCA § 4 grants EPA authority to establish new rules, by order or by consent agreement, to determine whether a chemical substance, mixture, or article imported (or manufactured for export only) presents an

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making pesticides. For the time being, Allied exported the raw materials, including HCP. Finally, Allied decided to produce Kepone. *See also* Tamara Dietrich, *VIMS: Kepone Could Soon be History in the James River*, DAILY PRESS (July 8, 2017, 8:35 PM) https://perma.cc/E5UE-TLBD.

42. *See* SULLIVAN, *supra* note 18, at 783–85; U.S. ENVTL. PROT. AGENCY, INITIAL REPORT TO CONGRESS ON THE EPA'S CAPACITY TO IMPLEMENT CERTAIN PROVISIONS OF THE FRANK R. LAUTENBERG CHEMICAL SAFETY FOR THE 21ST CENTURY ACT (2017), https://perma.cc/3CWH-X76V.

43. Class Lecture Note: Prof. Michael J. Walker, Fall 2017, U. Md. Carey School of Law (on file with author).

44. U.S. ENVTL. PROTECTION AGENCY & OFF. OF CHEM. SAFETY AND POLLUTION PREVENTION, TSCA INVENTORY (2017), https://perma.cc/R6KM-BAXJ.

45. U.S. ENVTL. PROT. AGENCY, ASSESSING & MANAGING CHEMICALS UNDER TSCA: PRIORITIZING EXISTING CHEMICALS FOR RISK EVALUATION (2017), https://perma.cc/ND4H-Z86A (stating that prioritization is a seven-step process: (1) pre-prioritization; (2) candidate selection; (3) initiation; (4) screening review; (5) proposed designation; (6) final designation; (7) revision of designation). *See* 15 U.S.C. § 2605(a).

46. SULLIVAN, *supra* note 18, at 785 (defining "manufacturer").

47. *Id*. at 783.

48. *Id*.; 15 U.S.C. § 2603(a)(i)(A)–(B); 40 C.F.R. § 720.25 (1995) ("A new chemical substance is any chemical substance that is not currently listed on the [TSCA] inventory.").

49. 15 U.S.C. § 2603(a)(i)(A)–(B).

50. *Id*.

unreasonable risk of harm to health or the environment.[51]

Likewise, § 5 of TSCA requires notice to EPA regarding production, import, and use of a new chemical substance to the extent such information is "known to or reasonably ascertainable by" that person.[52] TSCA § 5 requires a person to comply with regulations issued under § 6(a).[53] Section 5 also imposes a duty to refrain from using PCBs unless permitted by EPA.[54] Additionally, TSCA asks a person to refrain from using chemical substances if he/she knows or has reason to know that the substance has been manufactured, produced, or distributed in violation of TSCA.[55]

In the 1980s, an EPA study found that a type of dyes, called azo dyes, may pose a significant health risk, but no unusual step was taken to reduce or abandon the use of azo dyes.[56] After thirty years, EPA noted again that azo dyes[57] can break down and may release carcinogenic aromatic amines, including benzidine-based dyes and benzidine congener-based dyes, beyond its threshold level in finished articles or the dyed parts.[58] EPA revealed that azo dyes presented a risk to the general population through release in the environment.[59]

Nevertheless, all leather tanneries and textile manufacturers use many of the substances that TSCA intends to control.[60] In the 1980s, the textile industry in the United States widely used formaldehyde, PCBs, azo dyes, and many other substances which inevitably discharged dye effluents, including formaldehyde, azo dyes, PCBs, cadmium, chromium, and other toxic substances into rivers.[61] Due to these substances' persistence, bioaccumlative, and toxic characteristics, they are exposed to the environment and eventually harm human health.[62]

Additionally, courts have recognized that the textile industry uses "sodium hypochlorite, peroxide, sodium hydrosulfite (in powder form), acetic acid, soap flake, sodium carbonate, cassofic FRW 3000, caustic soda, and chlorine."[63]

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51. *See, e.g.*, *id.*; Food & Water Watch, Inc. v. EPA, 302 F. Supp. 3d 1058, 1061 (E.D. Ca. 2018).

52. *See* 40 C.F.R. § 720.45 (1995).

53. SULLIVAN, *supra* note 18, at 787.

54. *Id.*

55. *Id.* at 830 (stating that EPA must consider "(a) benefits of the substance; (b) reasonably ascertainable economic consequences of the rule; and (c) the availability of technically and economically feasible alternatives").

56. U.S. ENVTL. PROT. AGENCY, DYES DERIVED FROM BENZIDINE AND ITS CONGENERS 3 (2010), https://perma.cc/2W65-87UR [hereinafter EPA'S DYES STUDY].

57. *See infra* Part II.

58. EPA'S DYES STUDY, *supra* note 56, at 5.

59. *Id.* ("Biodegradation studies indicate that the dyes would be expected to biodegrade at negligible to slow rates under aerobic conditions in the environment").

60. *See infra* Part II.

61. *See* U.S. ENVTL. PROTECTION AGENCY, SCIENCE INVENTORY: TREATABILITY OF WATER-SOLUBLE AZO DYES BY THE ACTIVATED SLUDGE PROCESS (1986) (revised on Dec. 12, 2005), available at https://perma.cc/7PCC-2WNZ [hereinafter EPA's Azo Dyes Study of 2005].

62. *See id.*; *cf.* Leese v. Lockheed Martin Corp., No. 11-5091, 2014 WL 3925510 (D.N.J. Aug. 12, 2014).

63. *See* Gay v. J.P. Stevens & Co., 339 S.E.2d 490, 492–93 (N.C. App. 1986).

Courts had also noted that when sodium hypochlorite was used in dye batches and when it was heated or came in contact with acid, it emitted toxic chlorine fumes.[64]

Furthermore, there are other shortcomings under TSCA. For example, when any chemical substance is manufactured or processed only in small quantities for research and development, TSCA exempts that substance from TSCA inventory.[65] Under the impurities exemption, TSCA also exempts any chemical substance, which is unintentionally present in another chemical substance.[66] The exemption applies only if the substance is manufactured, processed, or distributed in the United States.[67] Likewise, if substances are manufactured or imported solely for export from the United States, then they are excluded from premanufacture notice requirements but may be subjected to other provisions of the rule.[68] Importantly, TSCA exempts specific by-products from this rule.[69] Likewise, TSCA also exempts non-solid intermediates from the notice requirement.[70] TSCA authorizes EPA to determine whether a substance presents an unreasonable risk followed by a risk evaluation based on the data submitted by manufacturers.[71]

Recently, in *Town of Westport v. Monsanto Co.*,[72] some residents (plaintiffs) brought a products liability action against the defendants, Monsanto Company and Pharmacia Corporation ("Monsanto").[73] These plaintiffs alleged that Monsanto supplied polychlorinated biphenyls ("PCBs") and that the contractors used the PCBs in the construction of the school building in 1969.[74] The First Circuit Court of Appeals said that "[t]he risks that PCB . . . would cause adverse health effects could not have been 'reasonably foreseeable' in 1969 given that the existence of such risk remains unverified by scientific studies today."[75] The court said that "PCBs are 'invisible to the naked eye,' and 'lack a characteristic odor or appearance to alert users of their presence,' their only deleterious effect is their potential harm to health."[76]

Although TSCA is intended for broad precautionary measures, there are many ingredients commonly found in textile dyes and auxiliaries that raise serious health threats because harmful chemicals are unavoidable ingredients in the

64. *See id.*
65. Exemption for Research and Development, 40 C.F.R. § 720.36(a)(1) (1986).
66. Chemicals Not Subject to Notification Requirements, 40 C.F.R. § 720.30(h)(1) (1986).
67. *Id.*
68. *Id.* § 720.30(e)(1)–(2).
69. *Id.* § 720.30(h)(2).
70. *Id.* § 720.30(h)(8).
71. SULLIVAN, *supra* note 18, at 868.
72. Town of Westport v. Monsanto Co., 877 F.3d 58, 58 (1st Cir. 2017) (discussing the devastating effects of PCBs).
73. *Id.*
74. *Id.* at 64.
75. *Id.* at 66–67.
76. *Id.* at 66.

industry and TSCA is unable to account for the regulatory gap and raising technological advances for chemical substances.[77] Therefore, the recovery model is not adequate to control textile chemicals under TSCA even though TSCA may be a useful tool in other aspects of chemical regulation.

2. The Resource Conservation Recovery Act ("RCRA")

RCRA suffers the same defect as TSCA. For example, any textile facility which generates hazardous waste[78] is potentially subject to RCRA. The United States Supreme Court has established that RCRA is "a comprehensive environmental statute that governs the treatment, storage, and disposal of solid and hazardous waste."[79] The Court said that the "primary purpose . . . is to reduce the generation of hazardous waste and to ensure the proper treatment, storage, and disposal of that waste which is nonetheless generated," and "to minimize the present and future threat to human health and the environment."[80]

In 2015, EPA revised its 2008 rule in response to concerns raised by stakeholders about potential increases in risks to human health and the environment from hazardous secondary materials.[81] In the revised law, EPA defined "hazardous wastes" as waste that may (1) cause, or significantly contribute to, an increase in mortality or a growth in serious irreversible or incapacitating irreversible illness or (2) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.[82] Materials that are not solid wastes are not subject to regulation as hazardous wastes under RCRA Subtitle C.[83] Thus, the definition of solid waste plays a crucial role in defining the scope of EPA's authorities under Subtitle C of RCRA.[84]

RCRA empowers EPA to regulate hazardous wastes from cradle-to-grave through the rigorous safeguards and waste management procedures under Subtitle C.[85] Under this provision, EPA has promulgated standards for hazardous waste generators and transporters, and owners and operators of hazardous waste treatment, storage, and disposal facilities ("TSDF").[86] EPA is authorized to direct hazardous waste generators to comply with handling, recordkeeping, storage, and

77. *See infra* Part III; Sheila Kaplan, *E.P.A. Delays Bans on Uses of Hazardous Chemicals*, N.Y. TIMES (Dec. 19, 2017), https://perma.cc/3TMB-AUH4.

78. Definition of Solid Waste, 40 C.F.R. §§ 260.30, .31, .34, 261.2, .4.

79. Meghrig v. KFC W. Inc., 516 U.S. 479, 483 (1996).

80. *Id.* (citing 42 U.S.C. § 6902(b)); see H.R. Rep. No. 94-1491, at 4 (1976), as reprinted in 1976 U.S.C.C.A.N. 6238, 6241; s*ee also* EPA's RCRA FOCUS, *supra* note 17, at 8–9 (discussing how to reduce and minimize the hazardous wastes you generate).

81. Definition of Solid Waste, 40 C.F.R. §§ 261.2, .4.

82. *Id.*

83. *Id.*

84. *Id.*; *see also* EPA's RCRA FOCUS, *supra* note 17, at 6–7.

85. *See* 42 U.S.C. §§ 6921–6934 (2018); *see also* EPA's RCRA FOCUS, *supra* note 17, at 1.

86. *See* 42 U.S.C. §§ 6922–24 (2018).

monitoring requirements.[87] The RCRA statute also allows "states to develop, administer, and enforce their own hazardous waste programs, subject to EPA's authorization."[88]

Nevertheless, EPA has estimated that approximately 135 facilities, including textile establishments, have been using toluene, methyl ethyl ketone, methanol, xylenes, methyl isobutyl ketone, methylene chloride, trichloroethylene, n-hexane, glycol ethers, and formaldehyde.[89] EPA found that these chemicals have adverse health effects to the eyes, lungs, mucous membranes, central nervous system, and the liver.[90] EPA says that most of the textile chemicals, heavy metals, and solvents used in cleaning and "dyeing"[91] operations are hazardous waste and should be regulated under RCRA.[92]

For example, recently the North Carolina Court of Appeals noted that a former textile manufacturing facility operated in the state as a "knitwear business."[93] During that time, the facility used "underground tanks to store virgin and waste perchloroethylene ('PCE')."[94] However, the stored PCE leaked from the tanks and contaminated the soil.[95] A successor landowner excavated the storage tanks in 1985, but the successor left the contaminated soil.[96] Later in the 1990s, an administrative law judge ordered the closure of the site according to the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA") and RCRA.[97] While wrestling to enforce "so-called" stringent and comprehensive laws, the court found that the soil remained contaminated and had affected the groundwater in many areas due to PCE's chemical characteristics.[98]

Even though the United States has "draconian provisions" like in TSCA and RCRA, recently, DuPont, a chemical manufacturer, continued to manufacture perfluorooctanoic acid ("PFOA" or "C8"), which is used in the textile industry in making apparel and leather goods.[99] PFOA is a subcategory of the per-and

87. *See* 40 C.F.R § 262 (1993).

88. See 42 U.S.C. § 6926 (2018).

89. National Emission Standards for Hazardous Air Pollutants: Printing, Coating, and Dyeing of Fabrics and Other Textiles, 68 Fed. Reg. 32171, 32171 (final rule May 29, 2003)).

90. *Id*.

91. *See infra* Part II.

92. *See* EPA's RCRA FOCUS, *supra* note 17, at 2.

93. Wasco L.L.C. v. N.C. Dep't of Envtl. & Nat. Res., 799 S.E.2d 405, 408 (N.C. Ct. App. 2017).

94. *Id*.

95. *Id*.

96. *Id*.

97. *See id*.

98. *See id*.

99. *See, e.g*., U.S. ENVTL. PROT. AGENCY, E.I. DUPONT DE NEMOURS AND COMPANY PFOA SETTLEMENTS–TSCA/RCRA SETTLEMENT, https://perma.cc/S99R-NVWU (last updated Aug 24, 2019) [hereinafter EPA'S DUPONT RECORDS]; U.S. ENVTL. PROT. AGENCY, Long-Chain Per-fluorinated Chemicals (PFCs) Action Plan 2 (2009), https://perma.cc/RV6G-F2W5; U.S. ENVTL. PROT. AGENCY, BASIC INFORMATION ON PFAS https://perma.cc/HK4Y-8QAW (last updated Dec. 6, 2018) [hereinafter EPA'S BASIC INFORMATION ON PFAS].

polyfluorinated alkyl substances ("PFAS"), previously known as PFCs (per-and-polyfluorinated chemicals).[100] According to a recent study, there are more than 1,000 to 4,500 individual chemical substances that are grouped under the generic name of PFAS.[101]

It is clear that the textile industry has adopted a "use first, test later" approach. Furthermore, scientific, technical, safety, and compliance regarding chemicals legally rests with manufacturers. For example, in 2005, EPA imposed a $16.5 million penalty against DuPont for purposefully failing to disclose information about its use of PFOA, and its potential impact on human health and the environment.[102] Subsequently, DuPont agreed to phase out production and eliminate the use of PFOA from its products.[103] DuPont also agreed to provide "alternative drinking water or treatment for public or private water users living near . . . West Virginia if the level of PFOA detected in their drinking water was greater than the PFOA screening level established by a C-8 Assessment of Toxicity team."[104]

Recently, 3,550 plaintiffs filed a claim against DuPont alleging that DuPont continued to produce PFOA in Parkersburg, West Virginia, contaminating groundwater and injuring these plaintiffs.[105] According to the plaintiffs, "DuPont knew about the dangers of PFOA as far back as 1961, and knew in 1984 that the chemical was present in the local water supply and was being emitted in dust from the factory chimneys, yet did not disclose this to workers or the surrounding public."[106] The plaintiffs also claimed that DuPont "dumped and emitted over 1.7 million pounds of PFOA between 1951 and 2003."[107] Finally, EPA and DuPont jointly agreed to spend only $1.5 million in researching PFOA.[108] When chemical substances are cloaked under a generic name, chemical companies have a strong

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100. *National Industrial Chemicals Notification and Assessment Scheme, Per- and Polyfluorinated Alkyl Substances (PFAS)*, AUSTL. GOV'T DEP'T OF HEALTH, https://perma.cc/LR2W-2VYF (last updated Feb 7, 2019) (describing PFAS substances and common uses).

101. The Federal Role in the Toxic PFAS Chemical Crisis: Hearing Before the Subcomm. On Federal Spending Oversight and Emergency Management of the Comm. on Homeland Security and Governmental Affairs, 115th Cong. 7 (2018) (statement of Linda Birnbaum, Director, National Institute of Environmental Health Sciences and National Toxicology Program, National Institutes of Health, Department of Health and Human Services), https://perma.cc/M6H6-NJJF (explaining that there are 4, 700 substances classified under the general name of PFAS).

102. EPA'S DUPONT RECORDS, *supra* note 99.

103. *See* Juliet Eilperin, *Harmful Teflon Chemical to Be Eliminated by 2015*, WASH. POST (Jan. 26, 2006), https://perma.cc/7DHP-CQAY.

104. EPA'S DUPONT RECORDS, *supra* note 99.

105. Lauren Gensler, *DuPont Puts Toxic Exposure Lawsuits Behind Its With $671 Million Settlements*, FORBES (Feb. 13, 2017), https://perma.cc/3SF2-QJ63.

106. *DuPont Lawsuits (re PFOA pollution in USA)*, BUS. & HUMAN RIGHTS RES. CTR., https://perma.cc/PNC5-X5CC (last visited Oct. 5, 2019).

107. *Id.*

108. *Id.*

incentive not to disclose the actual name of chemicals to the general public.[109] These concerns expose the fundamental flaws in TSCA and RCRA's core objective.

Moreover, EPA says that waste from the production of certain dyes and pigments are hazardous waste.[110] However,

> Waste that contains less than the specified threshold levels of constituents of concern are not hazardous (e.g., aniline levels below 9,300 kg/yr). Moreover, regulatory exemptions are provided for waste either sent for disposal in landfills that meet specific design standards or treated in an approved combustion unit. Waste that does not qualify for these exemptions and that meets or exceeds the specified thresholds for any of the specific constituents of concern must be managed as listed hazardous waste.[111]

The recent cases discussed above expose the ultimate shortcomings under both TSCA and RCRA in regulating comprehensive prevention of health and environmental threats by the textile dyes and auxiliaries. Compounding the problem with these hazardous chemicals, the Centers for Disease Control and Prevention warns that:

> PFAS . . . have been a concern because they do not break down in the environment, can move through soils and contaminate drinking water sources, and they build up (bioaccumulate) in fish and wildlife. PFAS have been found in rivers and lakes and in many types of animals on land and in the water.[112]

3. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 ("CERCLA")

CERCLA, on the other hand, comes at the end of the event as a cleanup statute.[113] In the 1980s Congress enacted CERCLA in response to the severe environmental and health risks posed by industrial pollution, including the textile industry's pollution.[114] CERCLA "was designed to promote the 'timely cleanup of hazardous waste sites' and to ensure that those responsible for the contamination

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109. *See* Envtl. Defense Fund v. Envtl. Prot. Agency, 922 F.3d 446, 450, 456 (D.C. Cir. 2019) (stating that the EPA "sensibly determined" that companies benefit from identifying chemicals by a "descriptive generic name" rather than a "specific chemical identify").

110. U.S. ENVTL. PROT. AGENCY, WASTE FROM THE PRODUCTION OF DYES AND PIGMENTS LISTED AS HAZARDOUS (Feb. 2005), https://perma.cc/V788-U75D.

111. *Id.*

112. CENTERS FOR DISEASE CONTROL AND PREVENTION: NATIONAL BIOMONITORING PROGRAM, PER- AND POLYFLUORINATED SUBSTANCES (PFAS) FACTSHEET, https://perma.cc/8CBB-LJK7 (last reviewed Apr 7, 2017).

113. EPA's RCRA FOCUS, *supra* note 17, at 10.

114. Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 U.S.C. §§ 9601–75 (2018). *See* United States v. Bestfoods, 524 U.S. 51, 55 (1998) (describing liability under CERCLA); Burlington N. & Santa Fe Ry. Co. v. United States, 556 U.S. 599, 602 (2009) (same).

bore the costs of such cleanup efforts."[115] Since its enactment in 1980, Congress amended CERCLA by three subsequent laws: (1) the Superfund Amendments and Reauthorization Act of 1986; (2) the Asset Conservation, Lender Liability, and Deposit Insurance Protection Act of 1996; and (3) the Small Business Liability Relief and Brownfields Revitalization Act of 2002.[116]

CERCLA only activates when a textile manufacturer (or other users) leaves a site or abandons a site. The site is then known as a hazardous waste site—also known as a Superfund site—which contains poisonous substances that are often disposed of by multiple entities.[117] The Act defines response as "removal, remedy, and remedial action."[118] The Act further establishes removal as "the cleanup or removal of released hazardous substances from the environment" and any actions that may be necessary "in the event of the threat of release of hazardous substances into the environment."[119] Moreover, CERCLA "remedial action" means "actions consistent with permanent remedy taken instead of or in addition to removal actions . . . to *prevent or minimize the release of hazardous substances* so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment."[120]

CERCLA requires cleaning of the contaminated site.[121] Despite some broad-based recovery efforts by major stakeholders from the textile industry, state and local governments, and environmentalists, CERCLA is ineffective along with other major federal regulations because many textile dyes and other auxiliaries have bioaccumlative and persistent characteristics.[122] Furthermore, chemical reactions may occur immediately or over a period of decades.[123] Some of these substances may stay in the environment for many centuries. Therefore, the government is not at all equipped to deal with the ripple effect that textile chemicals may pose to future generations.

To that end, Senator Kamala Harris (D-CA) testified before the Senate Subcommittee on Federal Spending Oversight and Emergency Response

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115. *Burlington N. & Santa Fe Ry. Co.*, 556 U.S. at 602.

116. See, e.g., U.S. ENVTL. PROT. AGENCY, THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT ("SARA"), https://perma.cc/PRR6-8CL7 (last updated Jun 4, 2018); U.S. ENVTL. PROT. AGENCY, CERCLA LENDER LIABILITY EXEMPTION: UPDATED QUESTIONS AND ANSWERS (July 2007), https://perma.cc/9928-ADF9; U.S. ENVTL. PROT. AGENCY, SUMMARY OF THE SMALL BUSINESS LIABILITY RELIEF AND BROWNFIELDS REVITALIZATION ACT, https://perma.cc/8EQ3-CQ3M (last updated Jul 26, 2019).

117. *See* 42 U.S.C. §§ 9607(a)(1)–(4) (2018); United States v. All Research Corp., 551 U.S. 128, 138–39 (2007).

118. *See* 42 U.S.C. § 9601(25) (2018).

119. *Id.* § 9601(23). "[R]emoval" means "the cleanup or removal of released hazardous substances from the environment" and any actions that may be necessary "in the event of the threat of release of hazardous substances into the environment." *Id.*

120. *Id.* § 9601(24).

121. *See* PERCIVAL ET AL., *supra* note 1, at 409–12 (describing principle provisions of CERCLA).

122. *See infra* Part II.

123. *See infra* Part II.

Management that PFAS chemicals can be found in stain-resistant and water-repellent fabrics and have been in use since the 1940s.[124] Senator Harris was concerned that many water systems in California tested positive for PFAS concentrations above recommended levels.[125] During her opening statement, Senator Harris mentioned that PFAS can accumulate and stay in the human body for long periods with a potentially devastating impact and can cause increased cholesterol levels, low infant birth weights, thyroid hormone disruption, and an increased risk of cancer.[126]

The EPA's recent study says that "additional factors aside from chain length may affect the bioaccumulation potential and toxicity of individual PFAS."[127] It is challenging to determine the threshold for textile dyes and risks associated with the use of chemicals.[128] Therefore, regulating textile chemicals under the current regime of the resources-to-recovery model is effective in maintaining public health and the environment.

B. REGULATING TEXTILE CHEMICALS IN INDIA

Compared to the United States' Constitution, the Constitution of India provides protection for the environment.[129] From a regulatory perspective, it is said that "the Indian Constitution is one of the few in the world that contain specific provisions regarding environmental protection."[130] Under the Constitution of India, many regulatory programs have been enacted encapsulating the prevention and remediation of the environment.[131] To that end, the legal authority in India, Parliament, has passed many comprehensive regulatory programs under their Constitution.[132]

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124. *See* The Federal Role on the Toxic PFAS Chemical Crisis: Hearing Before the Subcomm. on Fed. Spending Oversight & Emergency Management of the Comm. on Homeland Sec. and Governmental Affairs United States Sen., 105th Cong. 3 (2018) [hereinafter U.S. Senate Hearing on PFAS Crisis]; U.S. ENVIRONMENTAL PROTECTION AGENCY, EPA'S PER AND POLYFLUOROALKYL SUBSTANCES (PFAS) ACTION PLAN 9 (Feb. 2019), https://perma.cc/M8NX-L77D [hereinafter EPA'S PFAS 2019 ACTION PLAN].

125. EPA'S PFAS 2019 ACTION PLAN, *supra* note 124, at 3.

126. U.S. SENATE HEARING ON PFAS CRISIS, *supra* note 124, at 8 ("Research conducted to date reveals statistically significant associations between human PFAS exposures and specific adverse human health outcomes. These include potential effects on children's cognitive and neurobehavioral development, immune system dysfunction, endocrine disruption, obesity, diabetes, lipid metabolism, and cancer.").

127. *Id.* at 11.

128. *See* PERCIVAL ET AL, *supra* note 1, at 244; *s*ee also CTS Corp. v. Waldburger, 573 U.S. 1, 5–6 (2014).

129. *See, e.g.*, O.V. NANDINATH, OXFORD HANDBOOK OF ENVIRONMENTAL DECISION MAKING IN INDIA: AN EIA MODEL, 2 (2d ed. 2015); Deepa Badrinarayana, *The "Right" Right to Environmental Protection: What We Can discern From the American and Indian Constitutional Experience*, 43 BROOK J. INT'L L. 75, 96–118 (2017) (discussing the right of environmental protection under the Constitution of India).

130. NANDINATH, *supra* note 129, at 2.

131. *Id.*

132. *See, e.g.*, The Environmental (Protection) Act, No. 29 of 1986, India Code (1993), § 4, http://indiacode.nic.in [hereinafter India's EA].

Under the constitutional authority, India's Parliament has enacted (i) the Environmental Protection Act of 1986; (ii) the Water Preservation and Control of Pollution Laws Act of 1977; (iii) the Air Prevention and Control of Pollution Act of 1981; (iv) the Factories Act of 1948, (v) Hazardous Waste Management and Handling Act of 1989; and (vi) Citizenship Provisions under Art 21 and 51(A), etc.[133] Additionally, Article 253 of the Constitution gives Parliament the power to enact laws on virtually any matter arising out of any international treaty, agreement, convention, or conference.[134]

1. The Environmental Protection Act of 1986 ("EA"): An Umbrella Provision

The Constitution of India embodies a significant commitment of central and state governments to protect and preserve the environment.[135] Under the constitutional authority, Parliament has enacted the Environmental Protection Act of 1986 ("EA") and delegated an ample power to the Ministry of Environment, Forest and Climate Change ("MEF").[136]

The EA is a popular tool that gives broad power to the central government on all environmental issues.[137] The EA empowers the central government to take all such measures as it deems necessary or desirable for protecting and improving the quality of the environment, and protecting, controlling, and abating environmental pollution.[138]

Additionally, the EA authorizes the central government "to restrict any area in which any industries, operations, or processes or class of industries, operations, and processes that must not be carried out or must be carried out, but are subject to certain safeguards."[139] The EA grants authority to the central government to take all measures necessary to safeguard the handling of hazardous substances, manufacturing processes, materials and substances that may cause environmental pollution.[140] Under this Act, the Center Pollution Control Board ("CPCB") is authorized to inspect the industrial facilities and any plant, equipment, machinery, manufacturing or method, material or substance.[141]

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133. *But see* BHABATOSH BANERJEE, CORPORATE ENVIRONMENTAL MANAGEMENT: A STUDY WITH REFERENCE TO INDIA 31 (2009) (discussing corporate governance and corporate responsibility in India).

134. *See* INDIA CONST. art. 253 *amended by* The Constitution (Ninety-fourth Amendment) Act, 2006 [hereinafter India Const.] ("Parliament has power to make any law for the whole or any part of the territory of India for implementing any treaty, agreement or convention with any other country or countries or any decision made at any international conference, association or other body.").

135. *See* NANDINATH, *supra* note 129, at 2; s*ee also* India's EA, *supra* note 132.

136. India's EA, *supra* note 132, § 23.

137. BANERJEE, *supra* note 133, at 37–38; India's EA, *supra* note 132, § 3(1).

138. India's EA, *supra* note 132, § 3(1).

139. *Id*. § 3(2)(v).

140. *Id*. § 3 (describing the Rules to regulate environmental pollution); *see also* The Environment (Protection) Rules, 1986, Gen. S. R. & O. (India), *available at* https://perma.cc/T6L8-QXJV [hereinafter India's EA Rules] (exercising power granted under § 6 and § 25 of the EA to prohibit and restrict on the handling of hazardous substances in different areas).

141. India's EA, *supra* note 132, § 10.

Moreover, the EA authorizes the central government to issue directions in writing to any person (or any authority) to close, prohibit, or regulate any industry, operation, or process, and to stop or restrict the supply of electricity or water or any other service.[142] Additionally, the EA also enforces an emission and discharge permit program as set forth by CPCB.[143] The CPCB consults with the states and reviews compliance with the established standards because the State Pollution Control Boards ("SPCBs) are responsible for monitoring compliance.[144] SPCBs cannot, however, lower ambient environmental quality or minimum emission standards fixed by CPCB.[145] Thus, CPCB establishes only the bare minimum standards nationwide based on feasibility and economic concerns.[146]

Conceptually, the EA is probably the most complex of all pollution abatement laws discussed in this Article because it often works in tandem with the Water Act and Air Act as discussed below. The CPCB has been given the authority to collect information, take samples for analysis, and enter and conduct inspections at any time.[147] It also may take emergency measures if an accident occurs or any unforeseen event is happening in the discharge of environmental pollution.[148] The CPCB may issue directions to close facilities or withdraw their supply of power or water by administrative order or proceedings.[149]

Under the Act, failure to comply can be prosecuted criminally and is punishable by fines and imprisonment.[150] EA gives authority to sanction depending on the nature and type of violation and other facts that the reviewing authority may determine. Interestingly, EA also allows citizens to enforce the act directly.[151]

The Supreme Court of India (SCI) in several cases has directed legislators and regulators to take necessary and additional steps to protect the environment and human health. For example, in *Indian Council for Enviro-Legal Action v. Union of India*,[152] one of the defendants, was producing "H" acid in large quantities for exports.[153] The SCI found that H-acid also generated highly toxic effluents—in particular, iron-based and gypsum-based sludge.[154] The SCI noted that these poisonous substances, if not adequately treated, might pose a grave threat to the land.[155] After acknowledging all three statutes and applicable code provisions in

142. *Id*. § 5.
143. India's EA Rules, *supra* note 140, at § 3.
144. *Id*.
145. See *id*.
146. *See id*.
147. India's EA, *supra* note 132, § 10. Power of entry and inspection is granted to any person who is functioning on behalf of the Central Gov.
148. *Id*. § 9.
149. *Id*. § 5.
150. *Id*. § 15.
151. *Id*. § 19 (cognizance of offence).
152. Indian Council for Enviro-Legal Action, (1996) 3 SCC 212 (India).
153. *Id*.
154. *Id*.
155. *Id*. at 219.

the statutes, the SCI concluded that the failure of the Central Government to carry out their statutory obligations to regulate pollution of soil and underground water constituted a violation of the right to life of affected persons.[156] Justice Jeevan Reddy provided the following insight into the government and the industry's ignorance of the law:[157]

> This writ petition filed by an environmentalist organization brings to light the woes of people living in the vicinity of chemical industrial plants in India. It highlights the disregard, nay, contempt for law and lawful authorities on the part of some among the emerging breed of entrepreneurs, taking advantage, as they do, of the country's need for industrialization and export earnings. Pursuit of profit has absolutely drained them of any feeling for fellow human beings — for that matter, for anything else. And the law seems to have been helpless. Systemic defects? It is such instances which have led many people in this country to believe that disregard of law pays and that the consequences of such disregard will never be visited upon them — particularly, if they are men with means. Strong words indeed — but nothing less would reflect the deep sense of hurt, the hearing of this case has instilled in us. The facts of the case will bear out these opening remarks.[158]

Similarly, in Sterlite Industries Ltd. v. Union of India,[159] SCI said that the Ministry of Environment and Forests, Government of India, and the Pollution Control Board had ignored the EA requirements and hastily granted environmental clearance and consent in violation of the Water Act and the EA.[160] The SCI made it clear that the defendants were liable for the damages of one hundred crores rupees that occurred to the environment from 1997 to 2012, but that would not stand in the way of any claim for damages for the period above or any other period in a civil court for any other forum by law.[161] In sum, the SCI left the issue open for any other claims that might come in the future. The SCI also pointed out that the environmental approval for setting up the copper smelter plant was granted to the defendants under EA by the authorized agency.[162] The SCI said that although the government acted rationally and allowed the environmental clearance, the plant failed to maintain emission and effluent standards and operated without renewal permission and thereby caused severe air and water pollution.[163]

Likewise, in *Vellore Citizens Welfare Forum v. Union of India*,[164] the SCI interpreted the sustainable development provision under Article 21, Article 41,

156. *Id*. at 236–38.
157. *See id*. at 217.
158. *Id*.
159. Sterlite Indus. Ltd. v. Union of India, (2013) 4 SCC 575 (India).
160. *Id*. at 583, 593.
161. *Id*. at 581, 606.
162. *Id*. at 581.
163. *Id*.
164. Vellore Citizens Welfare Forum v. Union of India, (1996) 5 SCC 647 (India).

and Article 48A of the Constitution, and the fundamental duty enumerated in Article 51A(g). In that case, plaintiffs filed public interest litigation against the government alleging that the local tanneries used 40 liters of water in finishing one kilogram of leather and discharged "dangerously enormous quantities of toxic effluents" that damaged the physio-chemical properties of the soil and have contaminated groundwater by percolation.[165] The plaintiffs alleged that the tanneries and other industries discharged untreated effluents in the town's primary source of drinking water and that the State was responsible for the discharge of industrial effluents that severely damaged plaintiffs' 35,000 hectares of agricultural land.[166] The plaintiffs argued that the tanneries used synthetic dyes and 170 chemicals in the chrome tanning processes, including sodium chloride, lime, sodium sulfate, chromium sulfate, fat liquor ammonia, and sulfuric acid.[167]

The SCI noted that the 584 tanneries severely polluted 350 out of 467 wells that were used for drinking and irrigation (and that women and children had to walk miles to get drinking water).[168] The SCI delivered the opinion in a heartwarming tone as stated below:

> If 40 liters of water with chemicals are required for one kilo of leather, with the production of 200 tons of leather per day at present and likely to be increased multifold in the next four to five years with the springing up of more tanneries like mushroom in and around the town, the magnitude of the effluent water used with chemicals and acids let out daily can be shockingly imagined. . . . The effluents are let out from the tanneries in the nearby lands, then to Goodar and Palar rivers. The lands, the rivulet and the river receive the effluents containing toxic chemicals and acids. The subsoil water is polluted ultimately affecting not only arable lands, wells used for agriculture but also drinking-water wells. The entire town and the villages situated nearby do not have good drinking water. Some of the influential and rich people are able to get drinking water from a far-off place connected by a few pipes. During rainy days and floods, the chemicals deposited into the rivers and lands spread out quickly to other lands. The effluents thus let out affect cultivation; either crops do not come up at all or if produced the yield is reduced abnormally too low . . . The tanners have come to stay. The industry is a foreign exchange earner. But one moot point is whether at the cost of the lives of lakhs of people with increasing human population the activities of the tanneries should be encouraged on monetary considerations. We find that the tanners have absolutely no regard for the healthy environment in and around their tanneries. The effluents discharged have been stored like a pond openly in most of the places adjacent to cultivable lands with easy access for the animals and the people. *The Municipality, which can exercise its powers as per the provisions of the Madras District Municipalities Act, 1920 (5 of 1920) more particularly under*

165. *Id.*
166. *Id.*
167. *Id.*
168. *Id.*

> *Sections 226 to 231, 249 to 253 and 338 to 342 seems to be a silent spectator*. Probably it does not want to antagonize the highly influential and stupendously rich tanners. The powers given under Section 63 of the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974) have not been exercised in the case of tanneries."[169]

The SCI was concerned with the issue of pollution caused by the textile industry and some 900 tanneries in Vellore District in the State of Tamil Nadu.[170] The SCI emphasized that:

> [T]he Environment Act contains useful provisions for controlling pollution. The main purpose of the Act is to create authority or authorities under Section 3(3) of the Act with adequate powers to control pollution and protect the environment. It is a pity that [to] date no authority has been constituted by the central government.[171]

The SCI centered its opinion around the central government by stating that the central government must assume its responsibility and statutory duty to protect the environment.

The textile industry's pollution has indeed created a long-term impact in India. Environmental degradation by industrial pollution and chemical discharges is a significant causal factor in enhancing and perpetuating poverty in rural India when such degradation impacts health, soil fertility, and quantity and quality of water.[172] In 2002, the United States Agency for International Development ("USAID") loaned $25 million to the government of Tamil Nadu and the local clothing industry to finance a new water delivery system.[173] The project would not only supply water for local industry that "was running out of water, a critical input for dyeing and bleaching" but also "thousands of slum dwellers in the area could finally have access to treated, running water."[174] Residents may have been using untreated textile effluent water for irrigation and drinking water.[175]

Additionally, Art. 48A of the Indian Constitution enjoins that the "State shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the country."[176] Moreover, Art. 47 imposes the duty on the State to improve public health as its primary duty.[177] Nevertheless, some public interest groups ("petitioners") recently filed a petition to the State of Rajasthan alleging

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169. *Id*. at 651.
170. *Id*.
171. *Id*.
172. *See* Armin Rosencranz & Kathleen D. Yurchak, *Progress on the Environmental Front: The Regulation of Industry & Development in India*, 19 HASTINGS INT'L & COMP. L. REV. 489, 493 (1996).
173. *See* Adam Matthews, *The Environmental Crisis in Your Closet*, NEWSWEEK (Aug. 03, 2015), https://perma.cc/JLC8-RV4A.
174. Id.
175. *See id*.
176. INDIA CONST. art. 48A.
177. INDIA CONST. art. 47.

that on agricultural land around the City of Jaipur, contrary to the land revenue laws, textile manufacturers ("defendants") constructed buildings and established industrial activity.[178] These petitioners alleged that textile units used dyes and other chemicals and discharged untreated textile effluent into their land and thus contaminated the soil and water.[179] The petitioners also argued that these textile defendants burnt plastic openly, emitting a significant amount of smoke.[180] It is interesting to note that these manufacturers did not secure permission from the Pollution Control Board before establishing their businesses.[181] The Rajasthan High Court ("RHC") ordered to seal the textile units.[182] The RHC reasoned that "[p]ollution laws are meant for the public good and public interest must take precedence over private interest."[183]

In the context of the textile industry, it is clear that laws are ineffective to protect basic human health and the environment, including land, water, and the air. Governments have failed to realize the impacts of unregulated textile industries and tanneries, which could be far-reaching and long-lasting. Even though we assume that the government is or will be mindful in the future through proper compliance and enforcement of its environmental protection laws, it is doubtful that the harmful effect of the discharges that have already been made will ever be mitigated, as the California court explained the toxic effect of the chemicals used in *City of Modesto v. Dow Chemical Co*.[184]

As an analytical matter, the law and statutory mandate present an additional problem. The critical environmental challenges resulting from textile pollution in India are related to the nexus of environmental degradation and poverty, as well as the temptation of economic growth through foreign investors because many textile businesses are run by "mom-and-pop" type entities. Furthermore, the central and state governments were meant to work in parallel with each other against the polluting textile industry, but rather it seems the government is helping the polluting industry, which was not the intent of the EA. In sum, the EA does not directly address the problem caused by the textile dyes and dyeing process in India. Lastly, the Water Preservation and Control of Pollution Laws Act of 1977 and the Air Prevention and Control of Pollution Act of 1981 fall inside the

178. *See* Mukesh Meena v. State of Rajasthan, (2018) Rajasthan HC 2 (India), https://perma.cc/A8ZH-FVL6.

179. *Id.*

180. *Id.*

181. *Id.*

182. *Id.*

183. *Id.*

184. City of Modesto v. Dow Chem. Co., 227 Cal. Rptr. 3d 764, 768 (Cal. Ct. App. 2018). *See infra* Part II. The City of Tirupur has about 400 garment factories and many lather tanneries. Since the SCI and State High Court ordered these tanneries to comply with the Court's order in establishing effluent treatment plants, the garment businesses of Tirupur illegally moved to neighboring state where they can continue using the chemicals as they please.

umbrella provision of the EA and do not have any independent significance because the EA itself is inadequate to address the textile pollution.

The EA's ineffectiveness can be demonstrated further when we examine the most seminal case decided by the Supreme Court of India in *M.C. Mehta v. Union of India* (the *Oleum Gas Leak Case*).[185] In that case, the SCI laid a foundation of harm caused by hazardous chemicals (or substances) and held that strict liability is the liability of such evils.[186] The SCI was concerned that the government's action was unconstitutional in protecting the "citizens' right to life" under the Constitution.[187] The SCI also emphasized the difficulty of measuring environmental damages.[188]

This series of cases show the dynamics of environmental justice concerns that shift the cost of pollution onto the low-income communities and their vulnerability to the government and the polluting industry. Despite robust laws and regulations, lack of compliance with any established norms is the second most significant cause of India's environmental pollution caused by the textile industry. Therefore, the core of sustainable development will be less likely to be maintained even though the current use of synthetic dyes continues under the resources-to-recovery model.

2. The Water Prevention and Control of Pollution Act ("Water Act")

In 1998, the Supreme Court of India, in *M.C. Mehta v. Union of India* (the *Ganga Pollution Case*)[189] addressed the issue of water pollution caused by tanneries.[190] The SCI held that the right to life under Art. 21 of the Constitution included the right to unpolluted water and air.[191] In that case, the SCI also noted that although the closure of tanneries might invite "unemployment, loss of revenue," the SCI paid particular attention to the right to "life, health and ecology [that] have greater importance to the people" as the framers of the Constitution intended.[192] The SCI commented that:

> although Parliament and the State Legislature had thus enacted laws, imposing duties on the Central and State Boards and the municipalities for the prevention and control of pollution of water, no adequate action had been taken pursuant to many of their provisions. 274.50 million liters a day of sewage water was being discharged into the river Ganga from the city of Kanpur, which was the highest in the State of U.P. Sewer cleaning had never been done systematically in Kanpur, and there was mal-functioning and choking of the city

185. M.C. Mehta v. Union of India, (1987) AIR 965 (India), https://perma.cc/T98W-MTJS.
186. *Id.*
187. *Id.*
188. *Id.*
189. M.C. Mehta v. Union of India, (1988) 1 SCC 471 (India), https://perma.cc/G845-Z4RV.
190. *Id.*
191. *Id.*
192. *Id.*

> sewerage. Pollution of water in the river Ganga was of the highest degree at Kanpur, and a large extent of misery, sickness and death due to infectious diseases arose out of water supplies.

As the SCI observed in M.C. Mehta and other cases, India's Water Act presents a great example of the textile industry's water pollution because the Act authorizes the state governments and SPCBs to implement the Act.[193] The SPCBs further delegate their duty further to local and municipal governments.[194] These local governments play an essential role in day-to-day "lifestyle changes" necessary for pollution prevention.

The Water Act vests regulatory authority in SPCBs and empowers SPCBs to establish and enforce effluent standards for facilities that discharge pollutants into bodies of water.[195] However, Art. 252 of the Indian Constitution enables Parliament to enact laws for two or more states by consent of the state legislatures and adoption of such legislation by any other state.[196] Under Section 2A of the EA, CPCB has published Environment Protection Rules ("EPR") establishing general and specific industry-based standards for certain types of effluents discharged (as stated in EP Rules' Schedules I and VI).[197]

The SPCBs control sewage and industrial effluent discharge through a comprehensive permitting system.[198] Under the permitting system, SPCBs are authorized to approve, reject, or consent to discharge.[199] The Act empowers SPCBs to execute any work required under the consent order and recover expenses from the polluting facilities.[200] The SPCBs can restrain pollution through the courts.[201] Likewise, SPCBs may issue directions to close facilities or withdraw their power or water supply by administrative order.[202] Failure to comply with an SPCB order can be prosecuted criminally and can be punishable by fines and imprisonment.[203] The penalty provision includes "imprisonment, which may extend to three months or a fine which may extend to ten thousand rupees or with both."[204] However, in case of a continuing refusal or failure, there is an additional fine,

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193. The Water Prevention and Control of Pollution Act of 1974, No. 6 of 1974, India Code [hereinafter India's Water Act].

194. *Id.*

195. *Id.* § 17 (describing the functions of State Boards).

196. INDIA CONST. art. 252.

197. India's EA, *supra* note 132, § 3 (standards for emissions or discharge of environmental pollutants).

198. India's Water Act, *supra* note 193, § 17A(f)–(o).

199. *Id.* § 25 (describing restrictions on new outlets and new discharges).

200. *Id.* § 19 (describing the power of state gov. to restrict the application of the act in certain cases).

201. *Id.*

202. *Id.* § 33A.

203. *Id.* §§ 41 (describing failure to comply with the order under § 20), 42 (describing penalty provisions), 43 (describing the penalty provisions for contravention of § 24), 44 (describing the penalty provisions for contravention of § 25 and § 26).

204. *Id.* § 45.

which may extend to five thousand rupees per day until the entity complies.[205]

Like the EA citizenship provision, the Water Act also authorizes citizens to bring legal action and gives them the authority to sue SPCBs for the release of relevant information and reports.[206] The SPCBs are empowered to utilize a variety of tools to enforce the Water Act. They either directly collect data themselves through inspections at any time or request the data from facilities for analysis.[207]

CPCB coordinates activities among the states, advises the Central Government on water pollution issues, and develops a comprehensive plan for the control and prevention of water pollution.[208] If an SPCB fails to comply with the Water Act, then CPCB may perform the act on behalf of the state.[209] To provide financial incentives and retain control over these local and decentralized governments, Parliament enacted the Water Prevention and Control of Pollution Cess Act of 1977 ("Water Cess Act").[210] The Water Cess Act creates economic incentives for pollution control through a differential tax structure and requires local authorities to collect a Cess (tax) for water consumption and disposal by specified industries.[211] The Act also creates economic incentives through rebates on the applicable Cess when an industry installs an effluent treatment plant and the facility then meets the appropriate norm.[212]

The cases discussed above also suggest that the textile industry lacks the operating capacity of effluent discharge unit(s) either due to lack of a constant supply of electricity or the lack of operators' willingness to operate the facility lawfully (to save money). For example, in *Vellore Citizens' Welfare Forum v. Union of India*,[213] the Court noted that the defendant tanneries were given options either to construct common effluent treatment plants for a cluster of industries or to set up individual pollution control devices.[214] The SCI held that although CPCB agreed to provide a substantial subsidy for the construction of Common Effluent Treatment Plants ("CETPs"), "[i]t is a pity that [to] date most of the tanneries

205. *Id.*

206. *Id.* § 49 (describing cognizance of offences).

207. *Id.* §§ 20–21.

208. *Id.* § 16(1)–(3) (describing the functions of Central Board).

209. *Id.* § 18.

210. The Water Prevention and Control of Pollution Cess Act of 1977, No. 36 of 1977, INDIA CODE [hereinafter *The Cess Act*].

211. *Id.* §§ 3 (discussing levy and collection of *Cess*), 4 (describing a liability to pay), 6 (discussing assessment of *Cess*). The Water Cess Act creates economic incentives for pollution control through a differential tax structure and requires local authorities to collect a Cess (tax) for water consumption and disposal by specified industries. The Act also creates economic incentives through rebates on the applicable Cess when an industry installs the effluent treatment plant, and the facility meets the appropriate norm.

212. *Id.* § 7.

213. *See* Vellore Citizens Welfare Forum v. Union of India, (1996) 5 SCC 647 (India).

214. *Id.*

operating in the State of Tamil Nadu have not taken any steps to control the pollution caused by the discharge of effluent."[215]

A study shows that "all the metals like Chromium, Iron, Manganese, Copper, Lead, and Cadmium were present in amounts larger than that prescribed as safe by the World Health Organization."[216] The environmental regulation of the textile industry and the seriousness of cases addressing the law further exemplify the weakness of India's environmental laws and its enforcement predicament. In light of the cases discussed in this section, it is clear that neither the textile industry nor the Government of India is concerned with textile dyes or other chemicals used in the industry. It seems that the industry is an export earning machine and other barriers (human health and environmental protection) are completely ignored.

3. The Air Prevention and Control of Pollution Act ("Air Act")

Manufacturing and using textile dyes produces toxic air. The major hazardous air pollutants emitted by the textile industry include toluene, methyl ethyl ketone ("MEK"), methanol, xylenes, methyl isobutyl ketone ("MIBK"), methylene chloride, trichloroethylene, n-hexane, glycol ethers (ethylene glycol), and formaldehyde.[217] However, India's Air Act suffers the same drawback as the EA and the Water Act because the Air Act depends on the EA.[218]

Parliament enacted the Air Prevention and Control of Pollution Act of 1981 under Art. 253 of the Constitution, which authorizes Parliament to enact laws to implement decisions made at international conferences.[219] Parliament used this authority to enact the Air Act as the result of the 1972 United Nations Conference on the Human Environment in Stockholm.[220] Since its enactment, no progress has been made to improve the air quality in India, at least in the textile context.

The Air Act considers the tendency of the majority of industries to congregate in heavily industrialized areas and contribute to local air pollution.[221] Unlike the EA, the Air Act limits the various pollutants discharged through industrial emissions and from specific human activities that may have a detrimental effect on the health of the people as well as on animal life, vegetation, and property.[222]

The Air Act provides many tools to SPCBs, like in the Water Act. Under the Air Act, SPCBs have authority to take measures of removing the pollutants, mitigating the damage, and issuing orders to the polluter prohibiting the emission of

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215. *Id*.

216. POLLUTANTS RELEASED BY TEXTILE INDUSTRY, *supra* note 8.

217. See Hazardous Wastes (Management and Handling) Rules, 1989 (India), https://perma.cc/56VN-KMB9.

218. *See id*.

219. INDIA CONST. art. 253; The Air Prevention and Control of Pollution Act of 1981, No. 14 of 1981, INDIA CODE, https://perma.cc/W46T-7HMH [hereinafter *India's Air Act*].

220. *See* JUSTICE T.S. DOABIA, ENVIRONMENTAL AND POLLUTION LAWS IN INDIA 475 (3d. ed. 2017).

221. *See India's Air Act*, *supra* note 219, § 54 (granting the state government power to make rules).

222. *Id*.

air pollutants into the atmosphere.[223] The Air Act empowers SPCBs to set emission and ambient air quality standards for the industry after consulting with CPCB.[224] The SPCBs can also bring charges against violators by seeking a restraining order until the entity complies with the Air Act.[225] Likewise, the Air Act authorizes SPCBs to close polluting facilities and withdraw their energy supply through administrative proceedings.[226] Like the Water Act, the Air Act allows SPCBs to prosecute the violators criminally. The punishment can be fines and imprisonment.[227]

4. The Hazardous Waste Management and Handling Act of 1989 ("HWA")

Under the umbrella provision of EA, the Hazardous Waste Management and Handling Act of 1989 ("HWA") is the only chemical regulation ever enacted in India. However, the HWA is generally used as an umbrella under EA to address any hazardous material and the consequences of its possible release. The Act defines hazardous waste to include "any waste that, by virtue of its characteristics, causes danger or is likely to cause danger to health or [the] environment, whether alone or when in contact with other wastes or substances."[228] However, wastes covered under the Water Act or Air Act are excluded.[229]

On the other hand, the textile industry is also a major source of hazardous waste generated from effluent treatment plant sludge, used oil, empty containers of dyes, and other chemicals used in the process, etc.[230] For example, sulfide wastes must meet the threshold of more than 20,000 mg/kg.[231] However, many small entities can be easily excluded under this threshold. Additionally, the text of the law suggests that it was predominantly enacted for the purpose of imports and exports rather than for the protection of its citizens.[232]

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223. *Id*. § 22A (explaining the Power of Board to make application to court for restraining persons from causing air pollution).

224. *Id*. §§ 17(g), 2(1).

225. *See id*. § 22A.

226. *Id*. § 31A(1)–(4) (explaining an appeal procedure).

227. *Id*. §§ 37–39 (explaining penalty provisions for certain acts), 33(1) (explaining that the Air Act allows the SPCBs to allocate funds to prevent air pollution).

228. *See* ENVIRONMENTAL LAW INSTITUTE, ENFORCING HAZARDOUS WASTES RULES IN INDIA: STRATEGIES AND TECHNIQUES FOR ACHIEVING INCREASED COMPLIANCE 9 (2014), https://perma.cc/VK89-29S8 [hereinafter *ELI's Enforcing Hazardous Wastes Rules in India*]

229. *Id*. at 5, 9.

230. *See* RAJASTHAN STATE POLLUTION CONTROL BD, GUIDELINES FOR ABATEMENT OF POLLUTION IN TEXTILE INDUSTRY DRAFT (2019), https://perma.cc/5DAQ-H8LN.

231. *See ELI's Enforcing Hazardous Wastes Rules in India*, *supra* note 228, at Appendix B, Schedule II.

232. *See id*.

C. REGULATING TEXTILE CHEMICALS IN CHINA

1. Law of the People's Republic of China on Environmental Protection

Like in India, China has three major provisions that regulate the textile industry. Like India's MEF, China's Ministry of Environmental Protection ("MEP") is responsible for protecting China's air, water, and land from pollution.[233] The MEP also formulates and directs national environmental policy, including establishing air and water quality standards, noise regulations, managing toxic and hazardous wastes, and implementing environmental impact assessments.[234] However, the Provincial Environmental Protection Bureaus ("PEP") are responsible for the enforcement of MEP's regulations.[235] In the 1970s, China's Congress ("NPC") and the Standing Committee promulgated China's Environmental Protection Law ("EPL").[236]

Under the amended version of the EPL, China's government has enacted (1) an increased liability provision, (2) a heightened EIA in the top-down mode, (3) a disclosure requirement, and (4) a public litigation provision.[237] Under the liability provision, an aggrieved person may bring charges against violators within three years.[238] However, the EPL has not been officially published in English; therefore, the question of its successful implementation remains.

The Wall Street Journal published an article about a recent case under the EPL.[239] In that case, two nongovernmental organizations ("NGOs") successfully argued against polluters.[240] The environmental groups accused four mine operators of damaging about two hectares (4.4 acres) of land by stripping a mountainous area of trees.[241] The report said that "[y]ears of breakneck development have badly polluted China's air, water, and soil, prompting growing public complaints

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233. *See Ministry of Ecology and Environment Mandates*, THE PEOPLE'S REPUBLIC OF CHINA, https://perma.cc/FXH9-K6VS (last visited May 8, 2019).

234. *Id.*

235. *Id.*

236. Environmental Protection Law of the People's Republic of China (2014 Revision), 中华人民共和国环境保护法(2014 修订) (promulgated by Standing Comm. Nat'l People's Cong., Apr. 24, 2014, effective Jan. 1, 2015) [hereinafter China's EPL] (unofficial translation available at https://perma.cc/WV3V-877K). The original copy is not available and not yet updated at the NPC.Gov. Hence, this Article mostly relies on the old version of the EPL unless otherwise stated.

237. Id. §§ 62–64. *See also* ENVIRONMENTAL LAW AND POLICY GOVERNANCE IN CHINA 8 (Hideki Kitagawa, ed., 2017). The top-down model refers to how the government controls the agencies. For example, in the United States, we have two-tiered government structure: the federal government and the state governments. Since China has communism, the President controls from top to bottom and there no individualized state pollution control authorities. Once the President orders, it is a rule for all form his office to the all-way to local, provincial governments.

238. China's EPL, *supra* note 236, § 66.

239. Te-Ping Chen, *Chinese Court Penalizes Polluters Under the New Law*, THE WALL STREET J., Oct. 29, 2015, available at https://perma.cc/BT9T-MYDR.

240. *Id.*

241. *Id.*

and protests."[242] In addition to empowering more NGOs to sue polluters, this first revision to the country's environmental law since 1989 also increased penalties for those caught damaging the environment.[243] The Chinese court in southern Fujian province ordered four mine operators to pay 1.27 million yuan (about $200,000) in cleanup costs and legal costs for the two NGOs that brought the suits.[244] This recent development suggests that, in the future, NGOs will be able to sue on behalf of the public for environmental damages like in Indian cases.[245]

Like in India, China has environmental courts, and many environmental cases are litigated daily. However, unlike in India, China's environmental matters are not published, at least in the English language. On the positive side, China's judiciary is slowly leaning towards judicial reform. Therefore, we may be able to see some environmental cases in China regarding the textile industry.

Like India's EA, China's EPL is an umbrella provision that often works in tandem with China's Clean Air Act and Clean Water Act. Although India and China's environmental abatement tools are mostly doctrinal, any resulting scientific and technical damages are complicated to evaluate under the current regime of recovery approach.

2. The Law of the People's Republic of China on the Prevention and Control of Water Pollution ("CWP")

China's CWP traces its roots to the Water Act of 1984.[246] The CWP was amended in 1996, 2008, and 2018.[247] Like India's Water Act, the CWP says that the Act's ultimate goal is the "prevention and control of pollution of rivers, lakes, canals, irrigation channels, reservoirs and other surface water bodies and groundwater bodies."[248]

The CWP also includes standards and planning for prevention and control of water pollution. For example, the State Council establishes national water quality standards, but the people's governments of provinces, autonomous regions, and municipalities, who are directly under the central government, can develop their water standards so long as the standards are either equivalent to or higher than the national norms.[249] For major rivers, the State Council and the people's governments may jointly establish a standard that applies to provisional boundaries

242. *Id*.
243. *Id*.
244. *Id*.
245. *Id*.
246. Water Pollution Prevention and Control Law of the People's Republic of China (2017 Revision) (中华人民共和国水污染防治法(2017修正) (promulgated by the Standing Comm. Nat'l People's Cong., June 27, 2017, effective Jan. 1, 2018) [hereinafter CHINA'S CWP].
247. *Id*.
248. *Id*. art. 2.
249. *Id*. art. 12–14.

based on feasibility and technological availability.[250]

Additionally, the CWP supervises and manages water pollution prevention and control. Like India's Water Act provision, any new construction, reconstruction, or extensions of projects and other installations that directly or indirectly discharge pollutants into water bodies must overcome an Environmental Impact Assessment mandate and appropriate permit program as required under CWP.[251] The law also requires a permit to discharge. With a discharge permit, "industrial wastewater, medical sewage, and any other wastewater discharges are allowed."[252] Additionally, the law requires the monitoring of this activity and on-site inspections.[253] The CWP also provides comprehensive measures taken for the prevention and control of water pollution. Similarly, China's CWP also instructs thorough rules of liability for the violation of the Act.[254]

Despite these rules, Greenpeace says that China's textile industry consumes about 42 percent of the world's textile chemicals.[255] A study revealed that in 2015, China's "textile industry produced 1.84 billion tons of wastewater effluent, accounting for 10.1 percent of China's total industrial wastewater discharge."[256] The Chinese Government has found that China's major rivers are still heavily polluted.[257] China's textile industry has been engaged in lucrative international export of textile dyes, auxiliaries, and apparel leading to a textile market boom—this significant textile production in China has caused a considerable amount of water pollution.[258]

Recently, the government ordered many, if not most, of China's dye houses and dye production units to be shut down for inspections.[259] Eventually, Chinese investors started to purchase raw textile materials from India, which caused higher demand for dye production and a sudden cost increase. Halting dye production may lead China's manufacturers to purchase dye from foreign

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250. *Id*. art. 13, 16.

251. *Id*. art. 19.

252. *Id*. art. 21.

253. *Id*. art. 30.

254. *Id*. art. 81 *et seq*.

255. *Chemicals Substitution in Textile Industry: Implementing Chemical Policies into the Textile Supply Chain*, GREENPEACE, (March 25, 2013), https://perma.cc/PHW2-8QZC (explaining hazardous chemicals in textile industries).

256. *Id*.

257. *See, e.g*., CHINA WATER RISK, *2017 State of Ecology & Environment Review* (June 14, 2018), https://perma.cc/K4WE-ZZFW (showing that only 32 percent of water is of good quality); Linda GREER ET AL., THE TEXTILE INDUSTRY LEAPS FORWARD WITH CLEAN BY DESIGN: LESS ENVIRONMENTAL IMPACTS WITH BIGGER PROFITS 5 (2015), https://perma.cc/WLA6-2KGV.

258. GREER, *supra* note 257, at 5 (stating that China produces an enormous quantity of fabric for the world—more than 80 billion meters annually—and is responsible for more than 50 percent of global production).

259. *See* Niyati Parikh & Kalpesh Damor, *Double Whammy: Spike in Dye, Cotton Prices Worry Textile Industry*, THE TIMES OF INDIA, June 23, 2018, *available at* https://perma.cc/CP7A-73ES; Tara Donaldson, *China Shutters 80,000 Factories in Pollution Crackdown*, Sourcing J., Oct. 27, 2017, *available at* https://perma.cc/U2X5-FD29.

manufacturers, just as American companies did. After laws and regulations became strict in the United States, many businesses turned to manufacturers in India, China, and Bangladesh.[260] In short, preventive or remedial law is an ineffective and impracticable approach to curbing the environmental pollution caused by the textile industry.[261]

3. The Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution ("CAA")

The textile industry is also notorious for its energy use, mostly derived from coal-fired power plants. China's unhealthy air is a significant concern of the global community. China adopted the Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution ("CAA") in 1987.[262] Nevertheless, China is one of the most substantial emitters of greenhouse gases, sulfur dioxide, mercury, and a range of other pollutants.[263]

As a theoretical matter, the CAA imposes stringent layers of "supervision clause[s]" under the top-down model. The CAA requires the State Council to promulgate national ambient air quality standards ("NAAQS").[264] Art. 7 authorizes the State Council to establish the NAAQS based on "the country's economic and technological conditions."[265] Then, the local people's governments (at or above the county level) can exercise "unified supervision" over the prevention and control of atmospheric pollution.[266]

The CAA also authorizes the governments of provinces, autonomous regions, and municipalities directly under the central government to establish supplemental standards with additional rules as appropriate to meet the effect-based NAAQS.[267] The CAA authorizes both administrations and individuals to protect the air and provides an opportunity to violators to abide by the law.[268] The

260. *See* discussion *supra* Part III.A. *See also, China Shuts Down Polyester Plants, Industry Sees Ripple Effect*, BARNHARDT PURIFIED COTTON BLOG (May 15, 2018), https://perma.cc/P9MZ-TMUD ("Many supply chains have simply uprooted their manufacturing regimes, taking their textile businesses to other low-cost, less-regulated markets in Asia.").

261. *Id;* GREER, *supra* note 257, at 7.

262. Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution Revised (中华人民共和国大气污染防治法) (promulgated by the Standing Comm. Nat'l People's Cong., Sept. 5, 1987, effective June 1, 1988) [hereinafter China's CAA]. China's CAA was amended in 2000, 2015, and most recently in 2018.

263. *See infra* Part III.C. *See also* Edward Wang, *Nearly 14,000 Companies in China Violate Pollution Rules*, N.Y. TIMES (June 13, 2017), https://perma.cc/YEG5-C6ES; Brian Spegele, *China Doubles Down on Coal Despite Climate Pledge*, WALL STREET J. (Nov. 8, 2016), https://perma.cc/Q8FF-DRCD; *cf*. Greer, *supra* note 257, at 7.

264. *See* China's CAA, *supra* note 262, art. 6.

265. *Id*. art. 7.

266. *Id*. art. 10.

267. *Id*. art. 6, 7.

268. *Id*. art. 5.

NAAQS is the bare minimum standard that the states must meet.[269] The law imposes a limitation on the administrative staff at the county level who are authorized to supervise compliance but may not bring charges against violators.[270] Art. 13 allows states or the local government to establish more stringent standards than the national standard.[271] Therefore, the local government bodies have discretion in enforcing the law.

Interestingly, China's CAA has a provision that allows the State to act on behalf of the industry discharger with a reasonable fee.[272] That means, if industries are violating the law or unable to keep up with the production and technicality of the CAA, the State can help them out with necessary tools and collect reasonable fees in return.[273] Like in India's Air Act, China's CAA also requires the agencies to make on-site inspections of the units under their jurisdiction that discharge pollutants.[274] The responsibility rests on the industry to report and respond to the government agencies.[275] However, the State Council is the one who needs to set up a network for reporting and unified administration.[276] The World Bank states:

> Textile manufacturing operations that may generate significant sources of air pollutants include the finishing processes (e.g. coating and dyeing operations). Other significant sources of air emissions in textile operations include drying, printing, fabric preparation, and wastewater treatment residues. Solvents may be emitted from coating / treatment finishing processes, drying ovens, and high-temperature drying and curing. Other potential emissions include formaldehyde, acids (especially acetic acid), and other volatile compounds, such as carriers and solvents, emitted during dyeing operations and from wastewater treatment operations. Solvent vapors may contain toxic compounds such as acetaldehyde, chlorofluorocarbons, dichlorobenzene, ethyl acetate, methylnaphthalene, chlorotoluene, among others.[277]

Although the environmental regulatory system in China is more than sufficient to regulate air pollution, implementation and enforcement of environmental regulations have been weak and questionable. Without any access to China's judicial systems and case laws in this direction, any discussion would be speculation.[278]

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269. *Id*. art. 13.
270. *Id*. art. 4.
271. *Id*.
272. Id. art. 14.
273. Id.
274. *Id*. art. 21.
275. *Id*. art. 6.
276. *Id*. art. 6, 46–65.
277. *Environmental, Health, and Safety Guidelines: Textile Manufacturing*, INT'L FIN. CORP. 7 (Apr. 30, 2007), https://perma.cc/V6M3-PVMT.
278. China's courts do not publish their cases. Everything is under the ruling party's control, including the courts. Although legal literature indicates that the system is changing to bring more transparency to the public, in a communist country, the government holds absolute power. NGOs are

On the bright side, as part of new environmental reform, China's government recently said that it would pay particular attention to industrial parks and municipal and rural discharges as sources of pollution.[279] Although the government's attention will be helpful as an injunctive tool to halt further degradation, it is not the ultimate solution for moving forward.

D. REGULATING TEXTILE CHEMICALS IN BANGLADESH

A recent description of Bangladesh tanneries provides a helpful introduction before exploring the legal jurisprudence of the country:

> Setting foot in the Hazaribagh neighborhood is an assault on the senses. The scene is seemingly post-apocalyptic, the stench overwhelming and almost vomit-inducing, a combination of garbage, human waste, rotting animal hides and toxic chemicals. The source of those hides and chemicals are tanneries like these, hundreds of them packed into two square miles. The facilities are often dark and suffocating. Workers rarely wear protective gear, and it doesn't take long to find children toiling away in dangerous conditions.[280]

The textile industry in Bangladesh is similar to that in the United States, India, and China. According to the World Bank:

> [A] variety of problems plague the apparel industry related to compliance, quality, reliability, and worker safety. All of these are obstacles to increased foreign investment. Another, sometimes overlooked, problem facing the industry is textile production's role in water pollution. *Industrial pollution accounts for 60% of pollution in the Dhaka watershed area*, and the textile industry is the second largest contributor after tanneries. *There are 719 washing, dyeing and finishing factories discharging wastewater to rivers in Dhaka* and according to IFC's best estimates this is generating as much as 200 metric tons of wastewater per ton of fabric. Despite being surrounded by four rivers, Dhaka's water supply to its 18 million residents is being threatened by the extremely high levels of pollution.[281]

The principal law surrounding environmental pollution is the Bangladesh Environmental Conservation Act of 1997 (and Bangladesh Environmental Conservation Rules of 1997).[282] Although Bangladesh is a significant contributor

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powerless and must obey the federal government. No one can go against the government's order. Cases are written in Chinese and not in English, which limits access to legal resources.

279. Lilly Kuo, *China's Environment Census's Reveals 50% Rise in Pollution Sources*, The Guardian (March 30, 2018), https://perma.cc/89UM-AWWJ.

280. Judy Woodruff, *Bangladesh's Leather Industry Exposes Workers and Children to Toxic Hazards*, PBS NEWSHOUR (Mar. 19, 2017), https://perma.cc/BZ28-RPQA.

281. *How Dialogue is Shifting Bangladesh's Textile Industry from Pollution Problem to Pollution Solution*, WORLD BANK (Feb. 15, 2017), https://perma.cc/45SS-CW94 (emphasis in original).

282. *See generally*, UNITED NATIONS ENVIRONMENT PROGRAMME, ET AL., BANGLADESH: STATE OF THE ENVIRONMENT 71 (2001), https://perma.cc/4JJC-R7RT.

to textile pollution, there is no law directly addressing air, water, or land pollution.[283] Bangladesh often borrows laws and regulations from India (and other neighboring countries). Water pollution is covered under the National Water Policy and treaties with the neighboring nations.[284] Air pollution is also a concern in Bangladesh. Bangladesh is also a significant emitter of Nitrous Oxide (NO_x) Sulfur Oxides (SO_x), Carbon monoxide (CO), Carbon dioxide (CO_2), and aromatic hydrocarbons.[285] Since the textile industry generates about 60–80 percent of export revenue and is the principal employment provider in Bangladesh, the laws are inevitably ignored by the government, the industry, and the people.

The New York Times published a report entitled "Bangladesh Pollution, Told in Colors and Smells."[286] The report said that the textile industry in Bangladesh is severely harming the health of school-going children.[287] It reported that within 300 yards of a local school were two garment factories, two dyeing operations, a textile mill, and other industrial plants.[288] Additionally, the school was surrounded by at least ten other dyeing plants and all of these textile units were discharging a significant amount of dyes, effluents, and wastes through an underground drainage channel that dumped into the canal behind the school.[289] As discussed earlier, Bangladesh produces and exports textiles for world-famous "companies like Pierre Cardin, Hugo Boss, Wal-Mart, Gap, and Levi Strauss, mostly from North America, Europe and very recently Australia."[290]

II. SCIENTIFIC AND TECHNICAL CHALLENGES: SUMMARY OF CHEMICAL TOXICOLOGY AND CLASSIFICATION OF SYNTHETIC TEXTILE CHEMICALS

As described above, laws in the United States, India, China, and Bangladesh regulate textile chemicals in various ways. This section summarizes the chemical toxicology that the laws seek to address, focusing on what types of chemicals are used and how these chemicals react and degrade the environment and impact human health. Regulations in the United States governing the textile industry mainly address production, disposal, and mitigation of textile dyes and other chemicals.[291] Therefore, understanding the chemical toxicology and classification aids in understanding why the current legal structure is ineffective in curbing textile pollution.

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283. *See id*. at 71.

284. *See id*. at 41.

285. *See generally* FLINT, *supra* note 23; Kumar & Choudhury, *supra* note 23, at 162–73.

286. *See* Jim Yardley, *Bangladesh Pollution, Told in Color and Smells*, N.Y. TIMES (July 14, 2013), https://perma.cc/2WU6-C8N3.

287. See id.

288. *See id*.

289. *Id*.

290. Naimul Haq, *Bangladesh's Garment Industry Boom Leaving Workers Behind*, INTER PRESS SERV. (Feb. 9, 2018), https://perma.cc/YU7U-R6C4.

291. *See supra* Part I.

TABLE 1:

Process	Dyes and Other Auxiliaries Used
Preparation or pre-treatments for natural fibers	Hydrogen-peroxide, alkali, antistatic agents, and lubricants, enzymes, etc.
Sizing	Tetrachloroethylene (as de-creasing agent)
De-sizing	Enzymes, salt, wetting agent, tetrachloroethylene, sodium meta titro benzene sulfonate (resistant salt)
Scouring	Alkali, salt, acetic acid, sulfuric acid, tetrachloroethylene, etc.
Bleaching	Sodium hypo chlorite, sodium chlorite, hydrogen peroxide, derivatives of diamino stilbene, coumarin
Mercerization	Sodium hydroxide, etc.
Dyeing	Softeners, acids, alkalis, resins
Finishing	Softeners, acids, alkalis, resins

An examination of the textile dyeing process reveals the breadth and magnitude of the toxicity of chemicals[292] used in the textile industry and their devastating effects.[293] In essence, the textile industry consumes a large number of dyes and other chemicals in an eight-step process:[294] (1) preparation, (2) sizing, (3) de-sizing, (4) scouring, (5) bleaching, (6) mercerization, (7) dyeing; and (8) finishing.[295] However, this eight-step process depends on the type of dye used, type of fiber used, and type of machine used at the various stages of fabrication.[296] The industry classifies the dyes according to their chemical structure, usage, and application methods. This complex infrastructure is outlined in Table 1.

Tetrachloroethylene is used as a solvent to remove oils from fabrics after knitting and weaving operations and as a carrier solvent for scouring, sizing, de-sizing, finishing, and bleaching.[297] The beauty of tetrachloroethylene is that it is

292. 15 U.S.C. § 2607(2)(A) (2018); *see also* 40 C.F.R. § 720.3(e) (2016).

293. *See, e.g.*, WORLD BANK INDIA'S TEXTILE REPORT, *infra* note 413, at 2–9.

294. *See infra* table 1.

295. *Id.*

296. *See* CHRISTIE, *supra* note 11, at 75–88; SHARMA, *supra* note 9, at 5–10; Kumar & Choudhury, *supra* note 23, at 146–62.

297. *See* TOXIC USE REDUCTION INST., FIVE CHEMICALS ALTERNATIVES ASSESSMENT 5-2 to 5-68 (2006), https://perma.cc/9AGL-E995 [hereinafter TURI STUDY]; City of Modesto v. Dow Chem. Co., 227 Cal. Rptr. 3d 764, 768 (Cal. Ct. App. 2018) (discussing the characteristics of *Perchloroethylene* (or tetrachloroethylene)).

used to dissolve fats, greases, waxes, and oils without harming raw material (natural or synthetic fibers).[298] It is also, however, a known carcinogen.[299]

In the United States, benzene is one of the twenty most widely used chemicals.[300] Benzene is used to make other chemicals that are then used to create nylon and other synthetic fibers.[301] Benzene is also used to make dyes, adhesives, coatings, and paint,[302] but the most extensive use of benzene in the textile industry is in the form of toluene.[303] EPA's July 1977 study found that "the solvents which have been deemed most appropriate for processing textile materials are chlorinated hydrocarbons, dichloromethane, 1,1,1-trichloromethane, and tetrachloroethane[,] all of which have been found applicable in textile processing."[304]

After forty years, a California court shed some light on tetrachloroethylene in *City of Modesto v. Dow Chemical Co*.[305] In *City of Modesto*, the court explained that "[T]etrachloroethylene, is a molecule containing chlorine atoms and carbon atoms. It is also characterized as a 'volatile halogenated organic compound,' a 'halogenated hydrocarbon', a 'chlorinated solvent' or a 'chlorinated hydrocarbon,' . . . All chlorinated hydrocarbons, like all solvents other than water, are 'toxic.'"[306] The court said that "if one cup of tetrachloroethylene were completely dissolved in water, it could contaminate 24 million gallons of groundwater. There are also regulations to prevent migration of tetrachloroethylene vapors in concentrations that could cause cancer."[307] The court gave further details regarding PCE contamination, which the textile industry consistently uses.[308] The court further stated:

> tetrachloroethylene is a colorless liquid and is therefore difficult to see once released into soil . . . Because in its pure form it is a dense non-aqueous phase liquid (DNAPL), it is heavier than water and so when placed in water it will sink and sit below the water. This is distinguished from a light non-aqueous phase liquid (LNAPL), such as gasoline, that is lighter than water and will

298. *See* TURI STUDY, *supra* note 297.

299. *See City of Modesto*, 227 Cal. Rptr. 3d at 768; AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY, *Health Effects Linked with Trichloroethylene (TCE), tetrachloroethylene (PCE), Benzene, and Vinyl Chloride (VC) Exposure*, https://perma.cc/LE9D-8LZM (last visited May 8, 2019).

300. *See Facts About Benzene*, CTRS. FOR DISEASE CONTROL & PREVENTION, https://perma.cc/85SD-QKJV (last visited Oct. 5, 2019); *Benzene*, CHEMICALSAFETYFACTS.ORG, https://perma.cc/5LAX-8Y4C (last visited Oct. 5, 2019).

301. *See id.*

302. *Id.*

303. *See* ALICE HAMILTON, INDUSTRIAL POISONING IN MAKING COAL-TAR DYES AND DYE INTERMEDIATES 8 (1921), available at https://perma.cc/4ZLC-HK28 (describing that if an alkyl group is attached to one of the carbons of the benzene ring, an *alkyl benzene* is formed. Toluene and Xylene are products of chemical reactions in the dye-bath).

304. U.S. ENVTL. PROT. AGENCY INDUSTRIAL ENVTL. RESEARCH LAB., USE OF ORGANIC SOLVENTS IN TEXTILE SIZING AND DESIZING 1 (1977), https://perma.cc/EBW2-5M4R.

305. City of Modesto v. Dow Chem. Co., 227 Cal. Rptr. 3d 764, 768 (Cal. Ct. App. 2018).

306. *Id.*

307. *Id.*

308. *Id.*

> therefore float on top. tetrachloroethylene also has lower viscosity (internal friction) than water and so it is very mobile and can move quickly to penetrate, . . . [tetrachloroethylene] does not readily dissolve in water—thus, "non-aqueous"—although it will dissolve very slowly over time. [Tetrachloroethylene] is also quite volatile, meaning it will quickly become a gas when it is heated or released into soil where it mixes with the soil gas . . . [tetrachloroethylene] is particularly "persistent" and "long lived" compared to other contaminants, making it extremely difficult to accomplish complete remediation.[309]

The textile process typically requires between twenty and two hundred parts water to every one-part fabric for scouring, dyeing, rinsing, and finishing textiles.[310] Additionally, textile processing and manufacturing requires large quantities of chemicals—between 10 to 100 percent of the weight of the fabric itself.[311] Most dye houses require a constant stream of incoming hot water for all stages of the dyeing process.[312] The textile dyeing process and water usage in that process depends on other factors, including shade, levelness, fastness, and consistency of fabric being used.[313]

As discussed earlier, there are various classes of dyes, which have different fastness properties and affinity towards different fibers as classified in Table 2, below.[314]

The production and use of textile dyes is a well-established industry in the United States and abroad.[315] However, some of the dyes used in the textile industry are carcinogens, including azo dyes, diphenylmethane, triphenylmethane, ketonimine, and anthraquinone.[316] The industry employs azo dyes in more than 50–70 percent of textile dyeing, more than in any other dyes, and it is considered the most important class of synthetic dyes.[317] Azo dyes provide very bright color, have excellent color fastness, are straightforward in application, are chemically stable, and versatile.[318] Azo dyes contain aromatic groups in their chemical

309. *Id*. at 769.

310. *See, e.g*., Sarah Murry, *Fixing the Fashion Industry*, NRDC (Jan. 5, 2016), https://perma.cc/2LQF-YYV9 (stating 200 parts water is used).

311. See id.; Chemicals Used in Textile Processing, O ECOTEXTILES BLOG (Jan. 10, 2013), https://perma.cc/X3VU-DR4K.

312. CHRISTIE, *supra* note 11, at 80.

313. CHRISTIE, *supra* note 11, at 79.

314. SHARMA, *supra* note 9, at 5–10, 335; CHRISTIE, *supra* note 11, at 83–87; Kumar & Choudhury, *supra* note 23, at 146–62 (explaining different types of dyes). *See also* JACQUIUM ROVIRA & JOSE DOMINGO, HUMAN HEALTH RISK DUE TO EXPOSURE TO INORGANIC AND ORGANIC CHEMICALS FROM TEXTILES: A REVIEW, 168 ENVIRONMENTAL RESEARCH 62–69 (2019), https://perma.cc/2MJP-L59T (describing that disperse dyes, used in manufacturing synthetic fibers, can cause skin allergies). Note that this list is not exhaustive.

315. *See supra* Part I.

316. CHRISTIE, *supra* note 11, at 62–63.

317. *Id*.

318. SHARMA, *supra* note 9, at 413–414.

TABLE 2:

Types of Dyes	Types of Fabric	Chemical class
Acid dyes:	Nylon, silk, wool, leather, and spandex	Derived from sodium salt of sulfonic acid: azo, anthraquinone, triphenylmethane, azine, xanthene, nitro and nitroso
Direct dyes:	Cotton, rayon, leather, and nylon	Derived from a formulation of benzedrine salts: azo, phthalocyanine, stilbene, and oxazine
Azoic dyes	Cotton, rayon, polyester	Derived from arylamides compounds: azo, naphthol
Disperse dyes	Polyester	Derived from non-ionic aromatic compounds: azo, anthraquinone, styryl, nitro, and benzodifuranone, phenols, and chlorinated aromatics (in concentrated form)
Sulfur dyes	Cotton, rayon (generally not applicable to wool and silk)	Derived from the formulation of compounds containing sulfur: sodium sulfite, sodium hydroxide, sodium sulfate, amines, aminophenol, sodium polysulfide
Basic or Cationic dyes	Silk, wool, cotton (when used with specific mordant)	Derived from acrylic – salt of triphenylmethane derivatives: azo, azine, acridine, oxazine, anthraquinone, triarylmethane, cyanine
Solvent dyes	Not directly used for textile (but used for stains, waxes, inks, oils etc.)	Azo, anthraquinone, triphenylmethane, triaryl methane, and phthalocyanine
Reactive dyes	Cotton, wool, nylon	Azo (including metallized azo), anthraquinone, triphenylmethane, formazan, and phthalocyanine, procyon, sodium carbonate
Vat dyes	Cotton, leather, wool, rayon	Anthraquinone, hydrosulfite (or sodium dithionite), indigoid

composition that allow them to be more durable than any other type of dye.[319] Presence of stable aromatic groups and complex aromatic structure make azo dyes resistant to light, acids, bases, oxygen, and biological and chemical degradation.[320]

Likewise, aromatic amines are essential in the textile industry because they are the precursors to many dyes and pigments, especially azo dyes.[321] Additionally, in every diazotization and coupling reaction of a primary aromatic amine, nitrosamines, hydrazine, hydroxyl-amines are inevitably formed.[322] Most azo dyes are created through the diazotization and coupling reaction.[323] However, nitrosamines, which are carcinogens, are transient and remain in the reaction vessel and discharged as effluent.[324]

The most potent carcinogens within this class contain two or more aromatic rings and either primary amino- (-NH2), methylamino- (-NHMe) or diethylamino- (-NMe2) groups.[325] Similarly, many nitroaromatic compounds are carcinogens, including benzidine, naphthylamine, ortho-toluidine (3,3-dimethyl benzidine), ortho-dianisidine (3,3-dimethoxy benzidine), 4-aminobiphenyl, 4-nitro-biphenyl, 2-amino-fluorene.[326]

In the preparation of fabric, surfactants are also used before the dyeing process, depending on the fiber being dyed. Therefore, a range of auxiliaries may be present in the dyebath, including electrolyte, PH, oxidizing/reducing, and surfactants, which remain present in the final bath even though some are chemically consumed in the process.[327] Hydrazine and many of its derivatives are carcinogens.[328] Hydroxyl-amines are usually used by the textile industry to produce coupling agents.[329] Similarly, carbon electrophiles may be carcinogenic if carbon electrophiles combine with four or more fused benzene rings.[330] Table 3 describes some basic chemicals that are discharged as effluents at the end of the process.[331]

Under the guise of toxicology and classification of synthetic dyes, one may find a brief glimpse of the risk associated with synthetic dyes. It is evident that the advancement and innovation of synthetic dyes have far-reaching consequences. These consequences may depend on the distribution and consumption of dyes, population sizes, population density, and the release of toxic effluents.

319. *Id.*
320. *Id.*
321. CHRISTIE, *supra* note 11, at 63.
322. *Id.*
323. *Id.*
324. *Id.* at 65.
325. *Id.*
326. *Id.* at 64.
327. *Id.*
328. *Id.*
329. *Id.*
330. *Id.* at 67.
331. *See* EPA'S RCRA FOCUS, *supra* note 17, at 1–8; ROVIRA & DOMINGO, *supra* note 314, at 62–68.

TABLE 3:

Process	Generic Substances Being Discharged
Sizing	Benzene, etc.
Bleaching	Cyanide, hydrogen peroxide, sodium silicate, and organic stabilizer, etc.
Dyeing	Sulphate, etc.
Printing	Nitrate, phosphate, etc.
Finishing	Lead tetrachloroethene, trichloroethylene, methylene chloride, chlorobenzene, toluene, methyl ethyl ketone, xylene, naphthalene derivates, PFASs, biocides, amines, metals, pentachlorophenol, halogen carriers, flame retardants, chromium, asbestos, etc.

Regulatory programs also play a role, either directly or indirectly, in environmental degradation. The textile dyes and dyeing are amorphous, having developed over successive centuries as one of the fundamental needs of our society. Importantly, many recent scientific studies show that the finished textile products (clothing that we wear) is a chemical sink for semi-volatile organic compounds ("SVOCs") through both indoor and outdoor exposures.[332] More importantly, the textile and its associated industries discharge about 2 to 40 percent of the dyes from textile dyeing operations.[333]

Although many discharge management techniques have been invented by industry and experts, without a proper effluent disposal legal regime, it is impossible to determine what has been discharged or how much was discharged. To some extent, the hazardous effect of chemicals on the environment and humans is not purely the result of reckless overreach by the dye manufacturers and persistent and unyielding demands by picky consumers, although they are probably the major initiators.[334] Recently, Levi's Jeans announced that it had created 100,000 pairs of jeans by using wastewater and is planning to extend the idea to a broader range of Levi Strauss products at factories in other parts of the world.[335] However, the core question is—will Levi's be able to eliminate dyes and the dyeing process completely?

More recently, the National Resources Defense Council in China ("NRDC") initiated the "clean by design" campaign "to leverage the purchasing power of

332. *See* ROVIRA & DOMINGO, *supra* note 314, at 63.

333. *See* CHRISTIE, *supra* note 11, at 77.

334. *See*, Bell *supra* note 12.

335. Thibault Worth, *Levi Strauss Tests 100% Recycled Water in Parts of its Jeans Production*, THE GUARDIAN (Feb 19, 2014), *available at* https://perma.cc/6S7X-D8QK.

multi-national corporations to reduce the environmental impacts of their manufacturing abroad."[336] NRDC claims that due to this campaign, China's textile giants were able to save (1) 61,000 tons of coal, (2) 400 tons of chemicals, (3) 3 million tons of water, and (4) 36 million Kw/h energy.[337]

Despite these efforts, illegal dyeing establishments are not rare in India, China, or in Bangladesh. The resources-to-recovery model will not sufficiently curb the problem of textile pollution.

III. FACTUAL CHALLENGES: THE DEVASTATING EFFECTS OF SYNTHETIC TEXTILE DYES ON HUMAN HEALTH AND THE ENVIRONMENT

With this understanding of the chemical processes and global economic forces of the textile dyeing industry, this section explores the factual challenges facing the industry in the United States and South Asia.

A. THE UNITED STATES

The United States textile industry employs approximately 341,300 people.[338] These manufacturing companies fabricate raw textile materials, yarns, fabrics, apparel, home furnishings, and other textile products.[339] The leather tanning industry is significantly decreasing in the United States, and most of this process is now outsourced to other countries.[340] In 1865, there were about 7,500 tanneries, but in 1900, there were only 1,000.[341] And by the year 1982, there were only 158 tanneries producing leather and discharging wastewaters to surface streams or through publicly owned wastewater treatment plants.[342]

Since the 1990s, many textile manufacturers in the United States were phased out and outsourced to South Asian countries like India, China, Bangladesh, Indonesia, Sri Lanka, etc.[343] Chemical regulatory reform in the United States, however, remained the focal point for these "phaseout incidents."[344] An EPA study shows that "dye production in the U.S. has been steadily declining for the

336. *See generally*, GREER, *supra* note 257.

337. *Id*. at 4.

338. *Textile Spotlight: Textile Industry in the United States*, SELECT USA, https://perma.cc/6PWZ-6KFS (last visited May 8, 2019).

339. *See id*.; 15 U.S.C. § 2602(9) (2018).

340. *See, e.g*., Leather Tanning and Finishing Effluent Limitations Guidelines, 61 Fed. Reg. 35680, 35681 (July 8, 1996) (final rule codified in 40 C.F.R. § 425); *U.S. Textile and Apparel Industries and Rural America*, U.S. DEP'T OF AGRIC., https://perma.cc/SJ43-ZJUX. *See also* Innotext, Inc. v. Petra'Lex USA, Inc., 694 F.3d 581, 585 (6th Cir. 2012) (describing how, "[i]n the 1990s, automakers outsourced work overseas to reduce labor cost . . . to manufacture automotive textile products.").

341. *Id*.

342. *Id*.

343. *Id*.

344. *See, e.g*., Bootie Cosgrove-Mather, *Levi Strauss Shuts all U.S. Plants*, CBS NEWS (Sep. 25, 2003, 4:38 PM.), *available at* https://perma.cc/U8X5-YFUB (describing Levi's plant closings in the U.S.); *Matthews*, *supra* note 173.

past decade, largely due to the increase in imported finished textiles from China and India and other less developed countries, which may have less stringent regulations on dye intermediates."[345] EPA found that, due to the threshold limit of 500,000 pounds per year for certain textile chemicals, no exposure or use data was reported in the United States.[346] The EPA said that none of the EPA listed dyes were available in the United States but the listed chemicals "could end up in the [United States] through importers, re-formulators, and others who distribute in small volumes."[347]

The main reason for pollution decline is a plethora of regulatory programs that currently target synthetic dyes in the United States.[348] As history reveals, many environmental laws were passed specifically to regulate synthetic dyes and the externalities they produced.[349] The regulatory agencies in the United States have addressed the chemicals associated with textile dyeing in two models: (1) the general model; and (2) the chemical-specific model.[350] For example, Congress passed the Clean Water Act,[351] the Clean Air Act,[352] CERCLA,[353] and several other statutes, treaties, and regulations. These statutes fall within the general model. On the other hand, RCRA,[354] TSCA,[355] EPCRA, and the Occupational Safety and Health Act[356] fall within the chemical-specific model. With this framework, both general and specific models result in a pragmatically based resource-to-recovery model. When chemical resources are invented, regulators direct their attention towards the recovery-or-prevention base model.

Nevertheless, the extent of environmental contamination throughout the United States may be striking, and the estimated costs of cleanup may be prodigious if fully discovered.[357] When statutes, regulations, and public concerns became more stringent in the United States, these highly polluting businesses

345. EPA'S DYES STUDY, *supra* note 56, at 3.

346. *Id.*

347. *Id. See Manufacturer News – 30 Shocking Figures and Facts in Global Textile and Apparel Industry*, CHAMBER OF COMMERCE HAW. (May 12, 2015), *available at* https://perma.cc/BF7Y-UTLG (stating that "[a]pparel manufacturing industry in the US has declined by more than 80% over the past two decades").

348. *See supra* Part I.

349. *See supra* Parts I–II.

350. *See supra* discussion Part I.

351. Clean Water Act, 33 U.S.C. §§ 1251 – 1274 (2018).

352. Clean Air Act, 42 U.S.C. §§ 7401–7431 (2018).

353. Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §§ 9601 – 9628 (2018); *see supra* Part I.A.3.

354. Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901 – 6992k (2018). See *supra* Part I. A.2.

355. Toxic Substances Control Act, 15 U.S.C. §§ 2601 – 2697, as amended by the Lautenberg Chemical Safety for the 21st Century Act (2016); *see supra* Part I.A.1.

356. Emergency Planning and Community Right-to-Know Act, 42 U.S.C. §§11001 *et seq.*; Occupational Safety and Health Administration, 29 U.S.C. §§651–678 (2018).

357. *See*, Cheryl Hogue, *Michigan Declares State of Emergency in Town with High PFOA, PFOS Levels in Drinking Water*, 96 C & EN MAGAZINE 32 (Aug. 1, 2018), https://perma.cc/E5SW-DJXB.

moved to countries where restricted materials were easily accessible as long as the activity was profitable.[358] For example, Gap, Wal-Mart, H & M, Levi Strauss, Armani, Victoria's Secret, Zara, and several other clothing companies have closed their manufacturing businesses in the United States and moved to countries where they can take advantage of low manufacturing costs, relaxed laws, and permitted exploitation of workers without any stringent liability.[359] However, these brands have taken steps towards corporate responsibility. According to the United Nations, 80 leading North American clothing brands and retailers signed the Accord on Fire and Building Safety in Bangladesh and support the Alliance for Bangladesh Worker Safety, a binding five-year initiative to improve safety standards in more than 500 factories to protect the work environment and worker's safety.[360]

The number of major American merchants "outsourcing" further demonstrates that the overall cost of outsourcing is significantly cheaper than maintaining establishments in the United States. One scholar explained the effect of the shift of American industry to developing nations: "[T]here is a sense of outrage on the part of many poor countries, where citizens are the most vulnerable to exports of hazardous drugs, pesticides, and food products;" the scholar warned that "developing nations will no longer tolerate being used a dumping grounds for products that had not been adequately tested."[361] Many questions remain about whether environmental law and regulations are really able to curb textile pollution, which has been spreading over the global arena.

B. INDIA

India was once known as a fabric Manchester. The dyes industry in India is mostly comprised of small-scale operations.[362] For example, there are only 50 organized facilities compared to 900 small facilities that produce a total of 150,000 tons of dyes and dye intermediates annually.[363] India accounts for approximately 16 percent of the world's production of dyestuff and dye intermediate, particularly reactive, acid, and direct dyes.[364] Importantly, most of the dye producing facilities are not in compliance with the pollution control norms. External and internal competition is rapidly squeezing the profit margin in the dye industry, resulting in severe setbacks for the labor force engaged in the sector.

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358. *See infra* Part III.

359. *Id.*

360. *See Bangladesh's Garment Industry to Improve Working Conditions,* U.N. NEWS CENTER, (Sept. 24, 2013), *available at* https://perma.cc/UM8L-PK9P.

361. Lairold M. Street, *U.S. Exports Banned for Domestic Use, But Exported to Third World Countries*, 6 MD. J. INT'L L. 95, 98 (1980).

362. MAHARASHTRA REPORT, *supra* note 7.

363. *See id.*

364. CHEMICALS: EXECUTIVE SUMMARY, INDIA BRAND EQUITY FOUND. 3 (May 2017), *available at* https://perma.cc/38AQ-Y9D6 [hereinafter IBEF CHEMICAL REPORT].

The industry and the government are investing hardly any money in research and development to solve these problems. Recent data indicate that the industry is investing only 1 percent of their total sales in research.[365]

The Indian textile industry employs about 40 million people directly and 60 million indirectly.[366] India also exports leather—many major brand designers have outsourced the manufacture of footwear, leather garments, and other leather goods to India.[367] India's 2,000 tanneries produce more than 2 billion square feet of leather annually, making the nation one of the world's largest exporters of processed leather.[368] Most of the tanneries are located in the states of West Bengal, Utter Pradesh, and Tamil Nadu, which collectively produce about 30 percent of India's exports of prepared leather products.[369] Millions of workers in the leather industry face hazardous working conditions and health risks while working with toxic chemicals like chromium IV.[370]

Although the dyeing industry supports workers through employment and economic benefits, it seriously endangers public health and the global environment. According to the Maharashtra Economic and Development Association, the demand for vat dyes, disperse dyes, direct dyes, and reactive dyes will continue to be very high despite knowledge of their harmful effects, primarily due to the outsourced operations of major brands.[371]

This shows that banning these hazardous substances in the future is unlikely. As discussed, the major environmental concerns with textile dyes and the manufacturing process include: (1) hazardous materials management; (2) wastewater; (3) emissions to air; (4) energy consumption; and (5) solid and liquid waste.[372] Recently, the New York Times noted the alarming levels of air pollution in New Delhi, which reached levels almost thirty times higher than what the World Health Organization considers safe to breathe.[373] Although the textile dyes and dye intermediates are mainly responsible for water pollution due to the use of azo

365. ENVTL. MGMT. CTR., LLC, CLEANER PRODUCTION OF DYES AND DYE INTERMEDIATES INDUSTRIES 15–16 (2012), available at https://perma.cc/WG5S-HUCU.

366. *Textile Industry & Market Growth in India*, INDIA BRAND EQUITY FOUND., March 2017, https://perma.cc/AK5Z-5MCY.

367. Press Release, India Committee of the Netherlands, Rights of Indian Leather Workers Systematically Violated (Mar. 15, 2017), https://perma.cc/7URG-7F5Q.

368. Larry C. Price & Debbie M. Price, *India: Toxic Tanneries*, PULITZER CENTER (Mar. 9, 2017), *available at* https://perma.cc/DCA6-UHSY.

369. *Id.*

370. *Id. See Hazardous Chemicals in Clothing*, GREENPEACE EAST ASIA (July 3, 2018), *available at* https://perma.cc/W5T4-AZZY [hereinafter GREENPEACE EAST ASIA].

371. MAHARASHTRA REPORT, *supra* note 7.

372. WORLD BANK GRP. INT'L FIN. CORP., ENVIRONMENTAL, HEALTH, AND SAFETY GUIDELINES FOR TEXTILE MANUFACTURING 2 (Apr. 30, 2007), *available at* https://perma.cc/GAE2-UZ5U [hereinafter WORLD BANK INDIA'S TEXTILE REPORT].

373. Kai Schultz, Hari Kumar & Jeffery Gentlemen, *In India, Air So Dirty Your Head Hurts*, N.Y. TIMES (Nov. 8, 2017), *available at* https://perma.cc/6LQ7-YPR5.

dyes and other phenolic compounds,[374] the leather industry is also equally responsible for massive and incurable water pollution mainly due to the use of hexavalent chromium and salts.[375]

Since the 1980s, many prominent Indian environmentalists and the SCI have addressed the pollution caused by the tanneries and the textile industry.[376] Only recently, the Minister of Environment, Forest and Climate Change presented a bill in Parliament declaring that exposure to chemicals used in textile dyeing units can affect human health, and regulation of this pollution is governed under the provision of the Environment Protection Act of 1986 because the Act prescribes standards for chromium and phenolic compounds.[377] The delay in recognizing the adverse impact of "chromium and phenolic compounds" and the inattentiveness of government organizations demonstrate that the central and state governments in India have not obeyed the Constitution of India, and have not responded to the scientific and technical challenges associated with textile chemicals.

The Parliament of India may have developed a robust environmental law, but the "external legal influence" and "the law" remains mostly on paper rather than in practice. Although the Judiciary has been active in India, the underpinnings and gate-keeping provisions of legislative inputs, and the implementation and enforcement efforts by the local, state, and union governments are the prime causes of environmental neglect in India.[378] Likewise, the Government's implementation and enforcement efforts are seriously questionable; it is unclear whether damages already sustained by resources in India will ever be recoverable.

C. CHINA

In recent years, China has been actively engaged in the textile market and has approximately 24,000–50,000 textile mills and enterprises.[379] China's textile

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374. WORLD BANK GRP., TANNING AND LEATHER FINISHING (1998), available at https://perma.cc/7AK7-3C5N.

375. *See* id. at 2–8; GREENPEACE EAST ASIA, *supra* note 370.

376. *See, e.g.*, Vellore Citizens Welfare Forum v. Union of India, (1996) 5 SCC 647 (describing how the industries that were discharging effluents in Palar River were ordered to stop discharging untreated effluents that were full of chemical substances); M.C. Mehta v. Union of India, (1993) Supp. (1) SCC 434 (stating that the industry must comply with industrial effluent discharge guidelines and that violators shall be punished by closing their establishments); M.C. Mehta (III) v. Union of India, (1991) Supp. (1) SCC 181 (ordering tanneries to comply with pollution control norms); A.Q.F. M. Yamuna v. Central Pollution Control Board (1999) 5 SCC 418; M.C. Mehta v. Union of India (1998) 9 SCC 448 (ordering the Central Pollution Control Board to show the names of the tanneries which had not paid the pollution fines). *See also* Doabia, *supra* note 220, at 462–63.

377. *See* Vishwa Mohan, *Exposure to Chemicals Used in Jeans Dyeing Units Can Affect Human Health, Says Government*, THE TIMES OF INDIA, Aug 8, 2017, *available at* https://perma.cc/354S-QDEY.

378. *See id.*

379. *See, e.g.*, GREENPEACE INT'L, TOXIC THREADS: PUTTING POLLUTION ON PARADE 9 (2012), *available at* https://perma.cc/XB7K-NS62 (stating that China has 50,000 textile mills); LARRY D. QIU,

industry accounts for over 60 percent of world chemical and synthetic textile production.[380] According to one source, more than 500 facilities are engaged in the manufacturing of dyes and dye intermediates and supply more than 40 percent of the world's total production of dyes and auxiliaries.[381]

According to the World Bank, approximately 20 percent of water pollution globally is caused by textile processing.[382] NGOs say that parts of India and China are among the most polluted areas in the world because of the textile industry.[383] Textile chemicals have highly polluted 70 percent of China's rivers.[384] Recently, China's Ministry of Water Resources declared that more than 80 percent of groundwater wells are heavily polluted and unfit for human consumption.[385] China's textile industry is the most significant producer of cotton shirts worldwide, creating an output of 60 million garments and overreaching nearly 4,700 acres of cotton farms, which produce 90 million yards of high-quality cotton fabric yearly.[386] While China's textile production accounts for almost 54 percent of the world's total production, it is also one of the top three "water wasting" industries in China, discharging over 2.5 billion tons of wastewater every year.[387]

The Chinese government recently had to shut down "tens of thousands of China's factories" that produced synthetic dyes in the Jiangsu province.[388] Consequently, the shutdown halted approximately 60 percent of China's denim-dyeing establishments, which accounted for roughly 30 percent of the global capacity.[389]

As discussed earlier, both India and China have a relatively comprehensive legal and regulatory framework in place to address the chemical regulations for the textile industry. However, the pollution caused by textile chemicals in India

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China's Textile and Clothing Industry 2 (2005), *available at* https://perma.cc/5PDY-Z83P (stating that China has about 24,000 textile and clothing establishments).

380. *See* Douglas Bulloch, *Textile Wars: Will 'Made in Italy' Replace 'Made in China'?* FORBES (Feb. 16, 2017), *available at* https://perma.cc/PV4J-VGM3.

381. MAHARASHTRA REPORT, *supra* note 7. *See also Alex Scott, Cutting Out Textile Pollution: Cleaning up One of the World's Dirtiest Industries Will Require New Technology and More*, 93 CHEMICAL & ENG'G NEWS 41,18–19 (October 19, 2015), *available at* https://perma.cc/9GLC-7WJC.

382. *See* Scott, *supra* note 381.

383. *Id.*

384. *See, e.g.*, Xinhua News Agency, *70% of Rivers, Lakes Polluted in China*, CHINA.ORG, available at https://perma.cc/6QTY-XRFZ (last visited May 8, 2019).

385. *See, e.g., More than 80% of Shallow Groundwater Wells in China Unfit for Human Use*, *Greenpeace Reaction*, GREENPEACE EAST ASIA.ORG, Apr. 16, 2016, *available at* https://perma.cc/8K2B-J6P5; Susan Egan Keane, *How Clean Are Your Clothes? Pollution from China's Textile Industry*, NATURAL RESOURCES DEFENSE COUNCIL, Apr. 11, 2012, *available at* https://perma.cc/USN7-PX8E.

386. *Manufacturer News – 30 Shocking Figures and Facts in Global Textile and Apparel Industry*, CHAMBER OF COMMERCE HAW. (May 12, 2015), https://perma.cc/686Q-ZWDR.

387. *Id.*

388. Melody M. Bomgardner, *These New Textile Dyeing Methods Could Make Fashion More Sustainable,* 96 CHEMICAL & ENG'G NEWS 29, July 15, 2018, *available at* https://perma.cc/V4VG-9USB.

389. *Id.*

and China would not have occurred if the laws and regulations were effective. Although the Chinese government's effort was indeed praiseworthy, the dangerous effects of the textile chemicals remains a challenging issue for the courts, the governments, and the people.

D. BANGLADESH

Environmental damage usually trails rapid industrialization in developing countries like Bangladesh. In Bangladesh, approximately 4.5 million workers work directly in approximately 4,600 garment factories to produce goods for export to the global market, principally to Europe and North America.[390] Additionally, another 8 to 10 million workers are involved in the industry indirectly. Two hundred leather tanneries employ 180,000 people, which are mostly outsourced by fashion icons like Armani, Picard, Bass, Hugo Boss, Timberland, Macy's, and Hush Puppies.[391] From spinning to weaving, and from knitwear to high street fashions, the textile and clothing industry in Bangladesh provides for the world's leading brands and retailers.[392] Since the late 1970s, Bangladesh started to produce export-oriented ready-made garments ("RMGs"), which produces the country's highest revenue-generating sector—contributing 81 percent of Bangladesh's total exports.[393]

While textile manufacturing is a very important industry in Bangladesh, it is plagued by environmental disasters. To meet the demand for garments, workers are forced to work for fourteen to sixteen hours per day, seven days a week, in unsafe and hazardous conditions, which often lead to work injuries and factory fires.[394] Thousands of workers have died and several thousand more have been wounded in 161 major factory fires.[395] Sexual harassment and discrimination are widespread, and many female workers have reported that employers do not uphold employment laws.[396] Child labor is extensive.[397] The record also shows

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390. *See* Naimul Haq, *Bangladesh's Garment Industry Boom Leaving Workers Behind*, INTER PRESS SERV. (Feb. 9, 2018), https://perma.cc/YU7U-R6C4.

391. *See* CHALLENGES FACING THE BANGLADESH LEATHER INDUSTRY, 118 CONFERENCE REPORT, LEATHER GOODS & FOOTWEAR MANUFACTURERS & EXPORTERS ASSOC. OF BANGLADESH 4, *available at* https://perma.cc/9JC7-9J3R (last visited May 8, 2019).

392. *See id.*

393. *Bangladesh Garment & Textile Machinery and Equipment*, EXPORT.GOV., (Oct 16, 2017), *available at* https://perma.cc/7W9Z-U57M [hereinafter Bangladesh's Commercial Guide].

394. *See Sweatshopts in Bangladesh*, WAR ON WANT, https://perma.cc/A8J4-98Q4 (last visited Oct. 5, 2019).

395. *See Fire and Other Health and Safety Incidents in the Bangladesh Garment Sector*, SOLIDARITY CTR. (Apr. 9, 2018), https://perma.cc/F6BM-K44E.

396. *See Sweatshopts in Bangladesh*, War on Want, https://perma.cc/A8J4-98Q4 (last visited Oct. 5, 2019). See also Symposium — The WTO at 10 and the Road to Hong Kong WTO Symposium Panel Summaries: XII, Textiles and Apparel Trade After the Agreement on Textiles and Clothing (ATC), 24 ARIZ. J. INT'L & COMP. L. 85, 85–86 (2007).

397. *Child Labor and Forced Labor Reports*, U.S. DEP'T OF LABOR, BUREAU OF INT'L LABOR AFFAIRS, https://perma.cc/BQ4N-QCUA (last visited Oct. 5, 2019).

that these workers are paid only $65 per month.[398]

Recently, the Government of Bangladesh introduced the Import Policy Order ("the Order"), which emphasizes easing the imports of raw materials for use in export-oriented industries.[399] The Order requires all imported products, product packaging, or containers to display the country of origin but does not apply to imports of coal, cotton, aluminum, or "export-oriented garment[s] and industrial related raw materials."[400] Despite political instability, global competition, factory safety issues, infrastructure deficiencies, and other struggles and limitations, RMG exports constitute approximately $28 billion out of $32 billion in total exports.[401]

In 2013, an eight-story building outside Dhaka, Bangladesh, collapsed, killing more than 1,100 people and injuring more than 2,000 others.[402] The building housed five garment factories that manufactured goods for major European and North American retailers.[403] After the accident, researchers at New York University began investing the garment industry and found that most garment factories were operating in disregard of any safety regulations.[404]

IV. AN ALTERNATIVE APPROACH: SUMMARY OF NATURAL, PLANT-BASED, ECO-DYES FOR THE TEXTILE INDUSTRY UNDER THE RESOURCES-TO-RESOURCES MODEL

Synthetic textile dyes pose clear health and environmental risks in areas where textile manufacturing is a major industry, such as Southern Asia. The existing legal regime has failed to reduce these risks. This Part analyzes the potential of natural dyes and a resource-to-resource regulation model to address these concerns.

A. NATURAL, PLANT-BASED DYES CAN PROVIDE VIBRANT COLORS

Natural dyes are derived directly from many indigenous plants, fruits, leaves, stems, seeds, roots, flora and fauna, and waste generated from many sources, which seem very promising for the sustainable development of natural textile dyes and other agents. Usually, natural textile dyes are renewable, sustainable, and bio-sourced products that pose little to no environmental risk. To that end, many small-scale firms have made revolutionary efforts to promote environmentally friendly,

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398. *Rana Plaza Collapse: Bangladesh Workers Demand Justice on Factory Disaster Anniversary*, ABC NEWS, (24 Apr. 2016, 5:40 AM), *available at* https://perma.cc/3MXU-M6ZJ.

399. *Bangladesh Prohibited & Restricted Imports*, EXPORT.GOV (Dec. 10, 2018), https://perma.cc/V5MY-TEES.

400. *See id.*

401. Bangladesh's Commercial Guide, *supra* note 393.

402. Kurtis Lee, *A Quick Guide to Bangladesh's Rana Plaza Collapse and its Lasting Impact*, L.A Times, June 2, 2015, *available at* https://perma.cc/F598-EAPV.

403. *Id.*

404. Paul M. Barrett et al., *Five Years After Rana Plaza: The Way Forward,* NYU STERN CTR. FOR BUS. & HUMAN RIGHTS (2018), *available at* https://perma.cc/AE2Z-4XQH.

non-toxic, botanical, and efficient eco-dyes for the textile industry.[405] Lately, much scientific research on natural dyes has been conducted to boost this revolution.[406] Despite much scientific evidence to incorporate natural eco-dyes in the commercial textile industry, federal and state governments, regulatory agencies, legal scholars, and industrial textile manufacturers have spent little to no effort on incorporating these elements.

Natural dyes are mainly derived from four main categories: (1) plants; (2) arthropods and marine invertebrates; (3) algae; and (4) bacteria and fungi.[407] One type of natural dye can produce durable and robust colors and may not require additional substances (auxiliaries) to obtain the desired outcome because these plant materials provide acids, which are necessary for the color to bond with the substrate (fabric) that is to be dyed.[408]

For example, to achieve a blue color, the only feasible option is indigo plants (*indigofera)*.[409] For many decades, India, Bengal, Java, and Central America have been using this plant as a dye.[410] Indigo harvesting time is short because the seeds germinate within four to five days once planted, and within three months, the plants are ready for harvesting.[411] Similarly, indigo plants require minimal maintenance and are cost effective because the plants absorb nitrogen from the atmosphere to grow.[412] The chemical substance contained in this plant—indigotin—is the same substance that is found in the synthetic dye.[413]

To achieve a red color, madder (rubia tinctorum), Indian madder (rubia cordifolia), and lac dye (cocus laccase) are predominantly used.[414] Madder cultivation is found throughout the Mediterranean region, Asia, Africa, and the Americas.[415] Madder is "generally characterized by whorls of lance-shaped leaves covered in clinging hairs and by small yellowish yellow that grow in clusters."[416] Madder gives different hues because each madder root gives a red color, and when the roots are grounded the resulting composite powder provides many shades of red.[417] Madder

405. *See infra* Part IV.D.

406. *See, e.g.*, Dr. Sukalyan Sengupta & Dr. Balan Singh, *Natural "Green" Dyes for the Textile Industry*, THE MASS. TOXIC USE REDUCTION INST. 4 (2003), *available at* https://perma.cc/CEW4-M6HH (last visited May 8, 2019).

407. *Id.* at 1, 3.

408. *See* FLINT, *supra* note 23, at 49–64, 67. *See also* M.L. Gulrajani, *Present Status of Natural Dyes*, 26 INDIAN J. OF FIBRE & TEXTILE RES. 191–92 (Mar.–June 2001).

409. *See id.* at 195.

410. *Id.*

411. *See Tamil Nadu Indigo from Southern India*, Wild Colours, *available at* http://www.wildcolours.co.uk/html/tamil_nadu_indigo.html (last visited May 8, 2019).

412. *See id.*

413. Gulrajani, *supra* note 408, at 195–96.

414. *Id.* at 196.

415. *Madder Plant*, ENCYCLOPEDIA BRITANNICA, *available at* https://perma.cc/QY7S-KHE3 (last visited Sept. 18, 2019).

416. *Id.*

417. *Id.*

dye and synthetic dye contain the same chemical components: alizarin and anthraquinone.[418] The cultivation of madder is exceptionally cheap and can cost approximately to $75–100 per kilogram.[419] Lac dye "is extracted from lac protective secretion of a small insect, lucifer lacca, which is a pest for many plant species, both wild and cultivated."[420]

Yellow is the most common color found in many natural sources. For example, some of the most common yellow dyes come from barberry (*berberis aristate*), turmeric (*curcuma longa*), weld (*reseda luteoda*), black oak (*quercus vetutina*), and Himalayan rhubarb (*rheum emodi*).[421] The Himalayan rhubarb is a critical anthraquinone-based yellow dye, which is extracted from three- to ten-year-old plants' roots, which are then dried and stored in airtight containers. This plant is a traditional natural dye that grows at elevations between 3,000 to 5,000 meters in the Himalayan mountains between India and Bhutan.[422] These "roots contain some anthraquinone derivatives and the most prominent among them is 'chrysophanic acid' is the primary source of the natural dye."[423]

B. AUXILIARIES USED IN NATURAL ECO-DYES: MORDANT, TANNINS, PROTEINS,[424] ALKALIS,[425] AND ACIDS[426] CAN BE DERIVED FROM NATURE

Some plant material may need additional or auxiliary materials, often referred to as mordant dyes, to bond with the color.[427] Mordants may be applied before, during, or after dyeing to change the desired hues.[428] Tannins are required for dyeing cotton, hemp, linen, and ramie.[429] The application of tannin as a precursor to a protein mordant is universal for yielding yellow, brown, grey, and black colors.[430] Tannins can

418. Gulrajani, *supra* note 408, at 196.

419. *Id*.

420. *Id*. at 197. Prof. Gulrajani says that lac dye is an acid dye and can be directly dyed on protein fibers such as wool and silk. It also produces very dark shades on Nylon. The hues can be modified by post-mordanting treatment with metal salts (i.e., dye vessel or dye pot used). *Id*.

421. *Id*.

422. Gulrajani, *supra* note 408 at 197–98.

423. *Id*. at 198. *See* Shahzad A. Pandith et al., *Evaluation of Anthraquinones from Himalayan Rhubarb* (Rheum emodi *Wall. Ex Meissn*.) *as Antiproliferative Agents*, 95 S. AFR. J. OF BOTANY 1, 1 (2014).

424. *See* FLINT, *supra* note 23, at 93–94 (describing that proteins can be sourced from (1) blood of from pigs, chickens, and cows; (2) gelatin sourced from the bones and hooves of bovine ruminants; (3) soybeans; (4) acorn flour; (5) rice flour; and (6) egg white).

425. *Id*. at 94–95 (describing that alkali can be sourced animals' urine or ashes made from dying and burning of peach, persimmon, and camellia plants).

426. *Id*. at 99–100 (describing that acid can be sourced from plants, including Rhubarb [*Rheum raponticum*] and soursobs [*Oxalis pes-caprae*], which contain oxalic acid within their leaves, stems, and roots; simple lemon juice; and household vinegar).

427. FLINT, *supra* note 23, at 49–64, 67.

428. *See id*.

429. *See* FLINT, *supra* note 23, at 92.

430. *Id*.

be found in oak barks (quercus sp.), spruce barks (picea sp.), chestnuts (castanea sativa), myrobalans (myrobolanus chebula), and pomegranates (punica granatum).[431]

In many developed countries, natural dyes and dyeing are used only in handcrafts, whereas synthetic dyes are used in all commercial aspects.[432] In many developing countries, natural dyes can provide not only a rich and wide-ranging source of dyestuff, but also income through sustainable harvest and sale of these dye plants.[433] Many dyes are prepared from tree waste or can be collected from specific unused products from a supermarket, including wilted spinach, beetroot leaves, cut-off red cabbage, onion skins, carrot tops, avocado pits, ripe berries, etc.[434] Some eco-dyers claim that broken tree branches collected from storms, colored maple leaves in fall, old pennies, and old rusty nails can also be a good source of natural dyes.[435]

Some studies show that naturally produced plants are potentially more lethal than synthetic dyes.[436] This risk can be avoided by proper agricultural or manufacturing techniques, as the U.S. Department of Agriculture ("USDA") has already been promoting in the United States.[437] Our increasing knowledge of the complexity of these plants, insects, and animals, and their potential use as dyes is seen as a new innovation, but the use of plant-based dyes and auxiliaries is as old as human civilization itself.[438] Before the invention of artificial dyes, textile dyes were prepared and used from plants, animals, soil, insects, and minerals.[439] In the United States, plant-based natural resources contribute to one-fourth of all prescription drugs, and microorganisms contributes as a source for about 3,000 antibiotics.[440] Additionally, as Professor Percival writes in his book:

> [T]he diversity of species is one of the earth's important resources. It is also the least utilized. We have come to depend completely on less than 1 percent of living species for our existence with remaining to wait untested and fallow.[441]

There are many natural resources that the textile industry can safely use without harming nature itself as described in this Article.[442]

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431. *See, e.g.*, FLINT, *supra* note 23, at 92; Gulrajani, *supra* note 408, at 198. See also Native Plant Dyes, U.S. Forest Serv., https://perma.cc/L6W9-YTVR (last visited May 8, 2019) [hereinafter USDA Report]; Making Natural Dyes from Plants, Pioneer Thinking Blog (June 19 2012), https://perma.cc/RQ28-XLBX; Tannins, U.S. Forest Serv., https://perma.cc/6C3P-QQZK (last visited Oct. 5, 2019).

432. *See* Gulrajani, *supra* note 408, at 192–93.

433. *See* Kumar & Choudhury, *supra* note 23, at 174. S*ee generally* FLINT, *supra* note 23.

434. FLINT, *supra* note 23, at 49–64.

435. *See id.*

436. *Id.*

437. *Id.*; *s*ee also USDA Report, supra note 431.

438. Kumar & Choudhury, *supra* note 23, at 162–174.

439. *Id.*

440. DALE D. GOBLE & ERIC T. FREYFOGLE, WILDLIFE LAW at 1038 (2d ed. 2010) (citing REED F. NOSS & ALLEN Y. COOPERRIDER, SAVING NATURE'S LEGACY 17–23 (1994)).

441. PERCIVAL ET AL., *supra* note 1, at 937 (citation omitted).

442. *Id.*

C. THEMES IN THE DEVELOPMENT OF NATURAL ECO-DYES IN THE UNITED STATES AND ABROAD

The previous section illustrates the impressive array of natural resources that can be used in textile dyeing. Many organizations, both national and international, have already initiated the first step in this direction by researching, sharing, and educating the public about the use of natural dyes and materials for the textile industry.[443] For example, Natural Dyes International ("NDI"), a non-profit organization, researches and educates on natural dyes and pigments.[444] The NDI advocates for the use of natural dyes through arranging worldwide exhibitions, workshops, and information sessions.[445] Additionally, the USDA has recognized hundreds of plants, trees, nuts, and roots as dye-yielding resources.[446] According to USDA:

> one American company is developing a natural indigo dye with the help of a $450,000 Small Business Innovation Research (SBIR) program Phase II grant from USDA's National Institute of Food and Agriculture (NIFA). Stony Creek Colors, located in Goodlettsville, Tenn., has found a more efficient way to produce natural indigo dyes using the indigo plant. The company's goal is to replace 2.8 percent of synthetic indigo dye with natural dyes in the next five years. To achieve that, Stony Creek Colors will need to produce 15,000 acres of indigo here in the United States.[447]

Additionally, the Textile Society of America, Inc. ("TSA") provides an international forum for the exchange and dissemination of information about textiles worldwide, including artistic, cultural, economic, historical, political, social, and technical perspectives of natural dyes.[448] Many North American Universities have collaborated with TSA by supporting research and offering other technical advice.[449]

In India, an organization called AVANI stepped forward to advocate for natural dyes.[450] AVANI claims that a range of colors, including brown, yellow, orange, red, blue, violet, and green can be successfully produced using local plant

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443. *See* NATURAL DYES INT'L, https://perma.cc/ZEM2-CPEM (last visited May 8, 2019) (providing various resources for natural dyers).

444. *See id.*

445. *Id.*

446. *See* USDA REPORT, supra note 431.

447. Kelly Flynn, *Red, White and Blue: Sustainable, Domestic Dye for Denim*, U.S. DEP'T OF AGRIC. BLOG, (Aug. 12, 2015), https://perma.cc/5E4W-SVPY.

448. *See About Us*, TEXTILE SOC'Y OF AM., https://perma.cc/9LSW-XW4X (last visited May 8, 2019).

449. *See, e.g.*, Jasmine Kornel, *Textile Close-Ups: Bloomington Blues*, TEXTILE SOC'Y OF AM. BLOG (Sept. 4, 2017), https://perma.cc/548C-KDDA (explaining indigo plantation initiative for self-sustainability).

450. See *Natural Dyes*, AVANI, https://perma.cc/D2V2-3Z73 (last visited May 8, 2019) (advocating natural dyes for textile industry).

species.[451] The Natural Resources Defense Council–India ("NRDC–India") has launched a revolutionary project initiating dyeing of coir yarn, coir mats, and mattings with natural dyes.[452] The NRDC–India states that natural dyes can easily replace synthetic dyes and can avoid pollution-causing dye effluents.[453] The NRDC–India's research reveals that the dyes can be extracted from cinnamon, red sandal, palamara, pomegranate, gallnut, turmeric, bixa orellana (annatto), tea, coffee, henna, hibiscus, onion, teak, papayas, marigold, nutmeg, and grape and can be used in the textile industry.[454] Currently, many organizations worldwide promote and advocate the use of natural dyes, rather than synthetic textile dyes. All of these environmentally conscious entities have the same perspective—that an incredible range of hues, including yellow, orange, green, red, blue, purple, grey, and brown, can easily be obtained from natural dyes.[455]

More recently, two Spanish clothing manufacturers, Archroma and Ternua, collaborated to manufacture T-shirts and sweatshirts by using non-edible waste products from agriculture and herbal industries instead of synthetic dyes.[456] Another recent development is that the Fraunhofer Institute for Interfacial Engineering and Biotechnology ("FIIEB") discovered that chitin derived from insects can be used in the textile industry where water-repellant properties are desired.[457] The idea behind this innovation is that the animal-feed industry uses a significant amount of insects as a source for protein in the feed and chitin is an integral waste of insects' skins and shells, which are often generated in large quantities in animal feed production.[458] Additionally, the insects reproduce quickly and the insects' larvae shed their skins several times, so a significant amount, approximately 40 percent of chitin, can be generated.[459] The FIIEB research also reveals that the resulting chitin from the insects' waste can be safely used in the textile industry where fluorocarbons are currently used as a water-repellant.[460]

Additionally, the United Nations noted that innovative approaches for more sustainable agriculture could support development of natural eco-dyes.[461] The United Nations also suggested strategies to help farmers improve yields and build

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451. *Id.*

452. *A Process for Dyeing Coir with Natural Colours*, NAT'L RES. DEV. CORP., https://perma.cc/76TU-QT67 (last visited April 20, 2019).

453. *Id.*

454. *Id.*

455. *See supra* Part II. *See also Industry of All Nations*, https://perma.cc/MV6U-PF5V (last visited on April 20, 2019) (advocating natural dyes and textiles).

456. *Recycling Nutshell Waste into Fashion*, INNOVATION IN TEXTILES (July 16, 2018), https://perma.cc/TS6A-SJRC.

457. *Insects Supply Chitin as Raw Material for Textiles Industry*, Innovation in Textiles (June 28, 2018), https://perma.cc/HM5Z-LY6R.

458. *Id.*

459. *Id.*

460. *Id.*

461. See generally Report of the World Comm. on Env't and Dev.: Our Common Future, U.N. Doc. A/43/427 (1987), https://perma.cc/QC84-DNA2.

resilience such as "green manuring," more significant use of nitrogen-fixing cover crops, sustainable soil management, and other agroforestry techniques.[462] The Sustainable Apparel Coalition has long been encouraging the global effort for the sustainable development of apparel, footwear, and textile through multinational, industrial partners, and NGOs that assess the environmental impact of materials used in global manufacturing.[463]

D. SUMMARY OF LEGAL JURISPRUDENCE IN REGULATING NATURAL ECO-DYES: HEALTH AND ENVIRONMENT BASED PARADIGMS UNDER THE RESOURCES-TO-RESOURCES MODEL

There is no law directly regulating natural eco-dyes. However, agriculture and farming have a significant impact on the natural landscape.[464] As discussed earlier, many dyes can be prepared from tree waste collected from specific leftover products from a supermarket, including wilted spinach, beetroot leaves, cut-off red cabbage, onion skins, carrot tops, avocado pits, ripe berries, etc. Rather than filling up our landfills, the waste product can safely be used for natural dye production. Additionally, many waste items, including broken tree branches, colored maple leaves in fall, old pennies, and old rusty nails, can be used to produce raw material for natural eco-dyes. How to regulate natural eco-dyes is a subject for legislators and beyond the scope of this Article.

However, regulation will be required to ensure that agricultural and farming processes for eco-dyes are sustainable. In the United States, for example, the relevant federal environmental law is divided into two groups: (1) natural resources development and protection; and (2) other federal environmental law, including, air, water, chemical regulation, and land as discussed in the resources-to-recovery model.[465] The United States could regulate agricultural and farming practices through the existing agricultural and farming laws, or it could enact new legislation specific to the resources necessary for developing natural eco-dyes. In the United States, the USDA has full power and authority over, and is responsible for, the administration of national agricultural programs.[466] Likewise, in India, the Ministry of Agriculture is the responsible authority governing natural eco-dyes. In the absence of statutes or regulations that comprehensively address natural eco-dyes, EPA should initiate regulatory reform combined with other existing

462. *Id.*

463. *See About Sustainable Apparel Coalition*, SUSTAINABLE APPAREL COALITION, https://perma.cc/9K7N-6BS3 (last visited May 8, 2019).

464. *See* Report of the World Comm. on Env't and Dev.: Our Common Future, at 136, U.N. Doc. A/43/427 (1987), https://perma.cc/QC84-DNA2; *see generally*, Peter Lehner & Nathan A. Rosenberg, *Legal Pathways to Carbon-Neutral Agriculture*, 47 Envtl. L. Rep. 10845 (2017); Robert L. Glicksman, *Sustainable Federal Land Management: Protecting Ecological Integrity and Preserving Environmental Principal*, 44 TULSA L. REV. 147 (2008) (explaining sustainability).

465. SULLIVAN, *supra* note 18, at 6.

466. *See* Morrow v. Clayton, 326 F.2d 36, 43 (10th Cir. 1963).

laws that may effectively outline regulating natural eco-dyes and should set an example of resources-to-resources approach by using natural eco-dyes.

E. A PROPOSAL TO EMBRACE A GIFT OF NATURE

Environmental degradation is occurring despite the regulations currently in place under the resources-to-recovery model. There is no dispute that the extensive use of toxic, synthetic dyes in the textile industry results in environmental and health risks in the United States, India, China, and Bangladesh.[467] While the current approach under the resources-to-recovery model may have been the most appropriate solution within the confines of current practice, it is a solution with many flaws. The use of synthetic dyes in the textile industry continues to devastate the environment and pose significant health threats.[468]

Textile manufacturing activities include the use of hazardous chemicals in pretreatment, dyeing, and other processes.[469] Many prohibited chemicals are used, including benzene, both chlorinated and fluoro-chlorinated solvents, tetrachloroethylene, perfluorocarbons, formaldehyde, phenols, and other volatile phenolic compounds.[470] There is evidence that extremely harmful asbestos, DDT, and other substances are still openly used in the textile industry.[471] Many of these substances are prohibited or restricted in the United States, but they are still manufactured and used through some other means by the industry.[472] Although environmental regulations incentivize the development of safe alternatives under the resources-to-recovery model, there is a severe regulatory gap in enactment, enforcement, and compliance within the United States, India, China, and Bangladesh.[473] Additionally, the resources-to-recovery model focuses on effluent controls to protect against pollution, but this offers only an incremental remedy.[474] The resources-to-resources model is a promising alternative because the use of natural eco-dyes relies on non-synthetic and non-petroleum-based products.

Despite the various regulations in place, India, China, and Bangladesh will continue be disproportionately affected if the current regime of using synthetic dyes continues. India, China, and Bangladesh have at least three things in common: (1) dense populations; (2) scarce resources, including water, clean air, and land, and (3) low income and rampant poverty with the competitiveness of

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467. *See supra* Part III.
468. *See supra* Part III.
469. *See supra* Part III.
470. *See* Rebecca Altman, *How the Benzene Tree Polluted the World*, THE ATLANTIC, Oct. 4, 2017, https://perma.cc/LJH5-FRV4 (explaining that benzene causes cancer); *supra* Part II.
471. See, e.g., Gideon v. Johns-Manville Sales Corp., 761 F.2d 1129, 1144 (5th Cir. 1985); Asbestos in India, Ctr. for Envtl. Health (May 23, 2017), https://perma.cc/YUB9-NQPZ.
472. *See id*.
473. *See supra* Part I.
474. *See supra* Parts I–III.

economic growth.[475] All three components are nothing but a recipe for disaster for incurable environmental degradation,[476] significant health risks,[477] and global warming.[478] Although the United States had been significantly regulating textile chemicals for the last 20 to 30 years, regulators have determined that the substances still pose a series of adverse impacts, demonstrating that the resources-to-recovery model is insufficient to address pollution caused by the textile industry.[479] See Table 4.[480]

While effluent treatment options, energy-efficiency, greenhouse gas (GHG), and pollution mitigation technologies may be attractive solutions, they have many shortcomings.[481] First, the textile industry currently provides goods to support about 7.1 billion people, and the industry will have to provide textiles for 9.5 billion people soon.[482] Therefore, the textile industry is expected to expand vigorously in the coming decades to meet the significant rise in demand.[483] Accordingly, a corresponding increase in the industry's water consumption, dye production, toxic discharges, energy generation, GHGs, and other poisonous emissions is likely.[484]

Second, wastewater from the textile industry often contains unused dyes from about 8–50 percent of the total applications in each process, resulting from incomplete exhaustion of the dyes, acids, undissolved solids, toxic compounds, other auxiliaries, fibers, and poisonous substances in the wastewater.[485] Many critics argue that even the most efficient effluent treatment may eliminate only half of the dyes, auxiliaries, and other wastes discharged.[486] Thus, hundreds of tons of textile dyes and auxiliaries are finding their way into the environment.[487]

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475. *See, e.g.*, PERCIVAL ET AL., *supra* note 1, at 1206 (explaining that poverty has a direct link with environmental degradation).

476. *See supra* Parts II, III.

477. *See supra* Part III.

478. GREER, *supra* note 257, at 5 (stating that China's textile industry generates more greenhouse gases).

479. *See supra* Part I.A.

480. *See, e.g.*, SCOTT, *supra* note 381 (describing health effects due to PFC exposures); *ELI's Enforcing Hazardous Wastes Rules in India*, *supra* note 228, Appendix B (discussing health effects due to exposures of phenols, benzine, tetrachloroethylene, trichloroethylene, cadmium, phenols, benzene, and polychlorinated biphenyls); Pub. Citizen Health Research Grp. v. U.S. Dep't of Labor, 557 F. 3d 165, 187 (3d Cir. 2009) (explaining health effects of Cr (VI)).

481. *Cf.* SHARMA, *supra* note 9, at 13–17 (describing absorption, membrane filtration, and ion exchange methods as alternatives methods).

482. PERCIVAL ET AL., *supra* note 1, at 1206.

483. *See id.*

484. *Id.*

485. *See* Shanmugam Senthilkumar et al, *Response Surface Optimization for Biodegradation of Textile Azo Dyes Using Isolated Bacterial Strain* Pseudomonas sp., 38 ARABIAN J. OF SCI. & ENG. 2279, 2279–80 (2013) (describing that non-exhausted chemicals are discharged through wastewater generated in the textile industry).

486. SHARMA, *supra* note 9, at 11 (citation omitted).

487. *Id.*

TABLE 4:

Textile Chemical (Generic Name)	Health Effects in Humans
Phenols	Likely to be carcinogenic to humans – liver damage – skin rashes and acne – decreased birth weight – short-term behavioral and immune system impacts in children exposed via breast milk.
Cadmium	Likely to be carcinogenic to humans – kidney, bone, and lung damage – stomach irritation, vomiting, diarrhea – birth defects in some animal studies.
Tetrachloroethylene	Likely to be carcinogenic to humans – dizziness, headaches, sleepiness, confusion, nausea, difficulty speaking and walking, unconsciousness
Trichloroethylene	Carcinogenic to humans – liver, kidney, and nervous system damage – impaired immune system and heart function – impaired fetal development – skin rashes, lung irritation, headaches, dizziness, nausea, unconsciousness.
PFAS/PFCs/HFCs	Research conducted to date reveals statistically significant associations between human PFAS exposures and specific adverse human health outcomes. These include potential effects on children's cognitive and neurobehavioral development, immune system dysfunction, endocrine disruption, obesity, diabetes, lipid metabolism, and cancer.
Formaldehydes	Likely to be carcinogenic to humans – blood cancer, nasal cancer, skin cancer, change in DNA by mutation in a subsequent generation
Polychlorinated Biphenyls	Likely to be carcinogenic to humans – liver damage – skin rashes and acne – decreased birth weight – short-term behavioral and immune system impacts in children exposed via breast milk.
Chromium VI	Compounds containing Cr (VI) can exist in mist, dust, or fume form, and have long been known to jeopardize the health of workers when inhaled, or upon contact with skin. Cr (VI) has been known to cause lung cancer, asthma, and damage to skin and the lining of the nasal passage. Compounds containing Cr (VI) in the production of chemical catalysts and pigments for textile dyes, paints, and inks.
Benzene	Carcinogenic to humans (leukemia) – harmful to bone marrow, decreased red blood cells, anemia – vomiting, stomach irritation – drowsiness dizziness, rapid heart rate, headaches, tremors, convulsions, unconsciousness.

Third, discharged dyes absorb sunlight, which inhibits the growth of bacteria that could help degrade impurities.[488] Fourth, research shows that textile wastewater exhibits considerable resistance to biodegradation because many dyes have complex chemical structures and are resistant to light, heat, and oxidation process.[489] Fifth, despite many innovative pieces of research, the dyes and auxiliaries in wastewater cannot be efficiently decolorized by conventional methods.[490] Research techniques include chemical, physical, and biological approaches, but these methods are costly and still have many uncertainties about their effectiveness.[491] Additionally, many of these wastewater treatment approaches are unavailable to many small-scale textile enterprises. Only a few effluent techniques have been accepted by the textile world.[492]

Furthermore, a large portion of the labor force in India, China, and Bangladesh is already vulnerable to serious health problems, including cancer, T.B., respiratory disorders, and other physical, mental, and biological disorders.[493] As discussed in this Article, the United States is no exception.[494] In these four countries, more than 300 million people are directly exposed to the toxic and prohibited chemicals used by the industry and billions of people would be indirectly affected from soil, air, land, and water contaminations.[495] The adverse effects may be much worse if thoroughly studied and discovered.

Although established regulations have many real applications, the law is a short-term fix because it only focuses on recovery or mitigating efforts that are immediately visible. There is a severe gap between legal and scientific developments. It is clear from the above discussion that law and science are not working in tandem.[496] Laws and regulations are a more immediate solution, but scientific research and development are still an ongoing process, and many uncertainties remain. For example, many of the above-discussed chemicals were once considered safe and heavily used in the United States and other developed nations, but recent research revealed that many of the textile chemicals are a hazardous to health and the environment.[497] Many rivers in India, China, and Bangladesh are dying, and the textile effluents have been polluting agricultural soils.[498]

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488. *Id.*
489. *Id.*
490. *Id.*
491. *Id.*
492. SHARMA, *supra* note 9, at 359.
493. *See supra* Parts I–II.
494. *See supra* Part III. *See also* Pioneer Finishing Corp. v. N.L.R.B., 667 F.2d 199, 201 (1st Cir. 1981) (the employer wanted the safety clause stricken from the contract).
495. *See supra* Part III.
496. PERCIVAL ET AL., *supra* note 1, at Ch. 11; *see supra* Part I.A.
497. Encourage Textile Manufacturers to Reduce Pollution, NAT. RES. DEF. COMM., https://perma.cc/7QDT-LGXY (last visited May 8, 2019); *see supra* Table 4.
498. *See supra* Part III.

Bangladesh is particularly vulnerable to environmental damage due to climate change, including an increased risk of sea level rise.[499] Whereas efforts to address the effluent discharges have been primarily focused on mitigation and, to a lesser degree, adaptation. The unremitting amount of wastewater and health hazards forces us to reconsider the resources-to-resources approach of natural eco-dyes in the textile industry, which has no adverse health and environmental consequences.

Finally, due to the global nature of the textile industry, it is almost impossible to understand the manufacturing history of every piece of fabric that is marketed around the globe. Most importantly, our regulatory approach encompassing chemical safety, follows "use first test later" approach. There is no "reverse engineering" jurisprudence in our risk-assessment analysis. Although the existing environmental laws have undoubtedly many positive implications, textile chemicals have persistent, bio-accumulative, and nondegradable characteristics.[500] Therefore, any regulatory attempts made under the resources-to-recovery model have not successfully moved the textile industry towards sustainable development and an environmentally friendly approach. The most effective alternative is to embrace natural eco-dyes to prevent the poisonous effects of synthetic dyes.

CONCLUSION

Existing environmental laws have many positive effects, but textile chemicals have many harmful footprints. Recent reforms and research reveal the positive potential of natural eco-dyes as an alternative to synthetic chemicals. The United States and other nations could initiate a widespread adoption of natural eco-dyes through legislation. A legislative or regulatory mandate for natural eco-dyes would inspire the development of sustainable natural eco-dyes, which has been a vision since the 1972 Stockholm Convention. The United States should initiate this essential reform of the harmful textile industry and inspire the commercialization and global adoption of natural eco-dyes.

499. Press Release, World Bank Group, Warming Climate to Hit Bangladesh Hard with Sea Level Rise, More Floods and Cyclones, World Bank Report Says (June 19, 2013), https://perma.cc/UNQ5-LV7Z.

500. *See supra* Part II.